NOOR FATIMA EDUCATION ACADEMY

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Knowledge at Your Fingertips

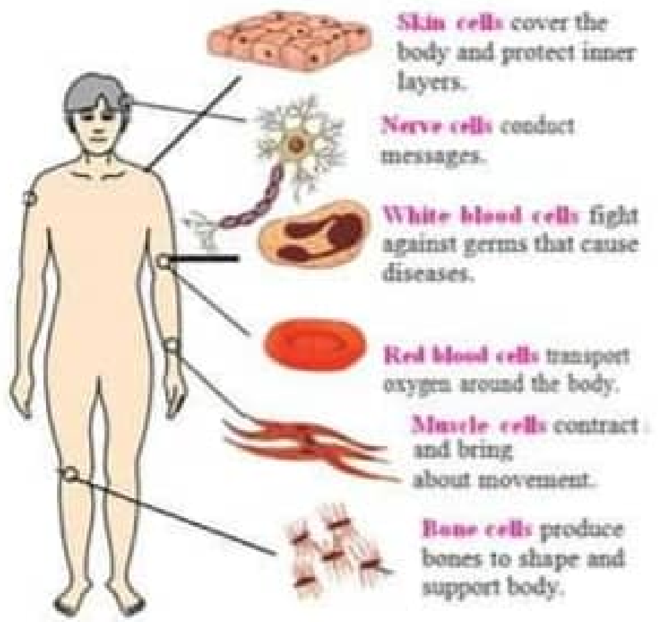
Class 6th science book key points

CHAPTER 1

CELLULAR ORGANIZATION OF PLANTS AND ANIMALS

Cells

- All living organisms are made of cells.
- Acell is the basic unit of structureand function of all living organisms.
- Plants and animals are made of trillions ofcells.
- Some living organisms consist of only one cell, e.g. bacteria. Cells are different in sizes, shapes and functions



- Different cells of our body perform different functions.
- Some cells are large enough to be seen with the naked eye, e.g. yolk ofan egg. But most cells are too small.
- The term **"cell"** was first used by an Englishscientist Robert Hooke in 1665. He observedtiny box like structures in a thin slice of a corkunder a microscope.

Microscope

- Microscope is an instrument which is used to see very small things that cannot be seen with **naked eye.**
- A light microscope has a base, an arm, a tube, a stage and two adjustment screws. Two lenses are fitted on the two ends of the tube. The end of the tube through which we observe an object is called an **eyepiece.**
- The lens near the object to be seen is called an **objective lens.** Light is passed through the object from below, using a mirror.
- The object to be seen is placed on a glass slide and then on the stage. To focus the object clearly in the microscope, two adjustment screws are used.
- We can view an object up to 1500 times bigger than its original size. Most of the cells are too small to be seen without a microscope.

A lightmicroscope

- The slide is a rectangularpiece of glass. The objectis placed on it to observeunder the microscope.
- An electron microscope can magnify the image up to 500,000 times. It shows clear images on a television screen. This microscope uses a beam of electrons instead of light.

Animal Cell and Plant Cell

Cell Wall

- The outermost covering of a plant cell is called the cell wall . It is made of a hard material, called cellulose.
- The cell wall supports the cell and gives it shape.
- Animal cells do not have a cell wall.

Cell Membrane

- The outermost covering of an animal cell is called the cell membrane.
- In plant cells it is present next to the cell wall.
- The cell membrane controls the movement of materials in and out of the cell.

Cytoplasm

- Jellylike material present inside the cell membrane is called cytoplasm.
- It contains water and other chemical substances.
- Many cell organelles (tiny cell structures) are present in it.
- Most of the cell functions take place in cytoplasm.

CELL ORGANELLES

Endoplasmic reticulum:

- It is a network of channels.
- The movement of materials in the cell takes place through the endoplasmic reticulum

Mitochondria:

- Mitochondria are cell parts that provide energy to the cell

Chloroplasts:

- Chloroplasts are parts of plant that contain chlorophyll. They trap energy from the Sun.
- Plants use the energy to make food

Vacuoles:

- Vacuoles store waste materials, water, air and food particles.
- In plant cells a single large vacuole is present, but in animal cells many small vacuoles are present.

Centrioles:

- Two centrioles are present near the nucleus of an animal cell.
- They play an important role in animal cell division.

Nucleus :

- The most important part of a cell is its **nucleus**.
- It controls all the activities of the cell. Therefore, a nucleus is the control centre of the cell.
- A thin membrane, called nuclear membrane, surrounds the nucleus.
- Many thread like structures called **chromosomes** are present in the nucleus.
- Chromosomes pass on the characteristics of the cell to new cells.
- The number of chromosomes is fixed in every cell. A human cell has 46 chromosomes.

Differences Between Plant and Animal Cells

- Cell membrane, nucleus, mitochondria and endoplasmic reticulum, etc.arepresentinbothplantand animal cells. Buttherearesomedifferencestoo.

Plant Cell	Animal
Cell wall is present.	Cell wall is absent.
Nucleus lies near the side of the cell wall because of a large vacuole	Nucleus lies in the center of the cell
Single large vacuole is present	Many small vacuoles are present
Chloroplasts are present	Chloroplasts are absent
Centrioles are absent	Centrioles are present

Unicellular and Multicellular Organisms

- The living organisms made of only one cell are called **unicellularorganisms**.
- Bacteria, chlamydomonas, amoeba and parameciumare unicellularorganisms.
- The living organisms made of more than one cell are called **multicellular organisms**.
- Plants and animals which we see around us are multicellular organisms

Cells Form Tissues

- Agroupofcellsperformingsame function is called a **tissue**.
- Plants and animals have different tissues in their bodies.

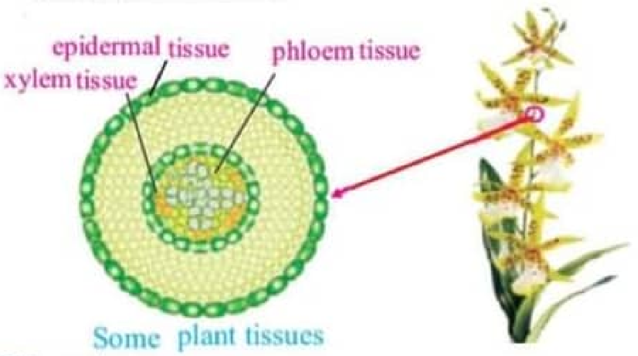
Some Plant Tissues

Epidermal tissue

- Epidermal tissue covers the roots, steand leaves of a plant.

Xylem tissue

- Xylem tissue conducts water and dissolved salts from roots to the leaves.



Some plant tissues

Phloem tissue

- Phloem tissue carries prepared food from leaves to other parts of plants.
- Mesophyll tissues present in leaves makefoodforthe plant..

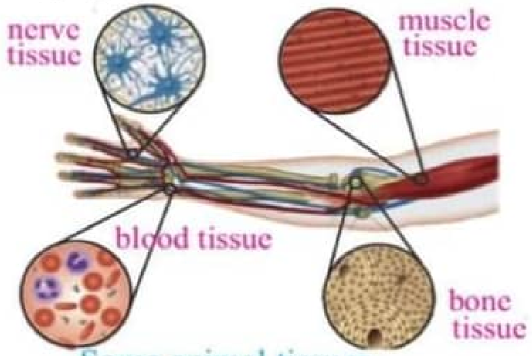
Some Animal Tissues

Muscle tissue

- In an animal's body muscle cells for muscle tissues to help in movement.

Bone tissue
- Bone tissue is formed by bone cells.
- This strong and solid tissue gives shape and support to the body.

Blood tissue
- Blood cells form blood tissue.
- This tissue carries materials from one part of the body to the other.



Some animal tissues

Tissues Form Organs
- Different tissues group together to form organs.
- Our body is made of a number of different organs such as the heart, lungs, eyes, brain, etc.
- An **organ** is made of different tissues which work together.
- An organ performs one or more than one functions.

Some Plant Organs
Leaf
- Plant leaf is an important organ. Leaves make food.

Flower
- A flower is another important organ of the plants.
- Flowers produce seeds.
- Seeds grow to produce new plants.

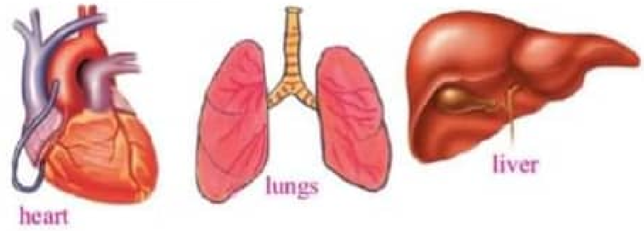
Root
- This organ holds the plant in the soil. Root also absorbs water and salts for the plant.

Some plant organs

Some Animal Organs
Heart
- The heart pumps the blood in blood vessels which carry it to all parts of the body.

Tongue
- Our tongue is an organ which tastes food and helps in digestion of food.

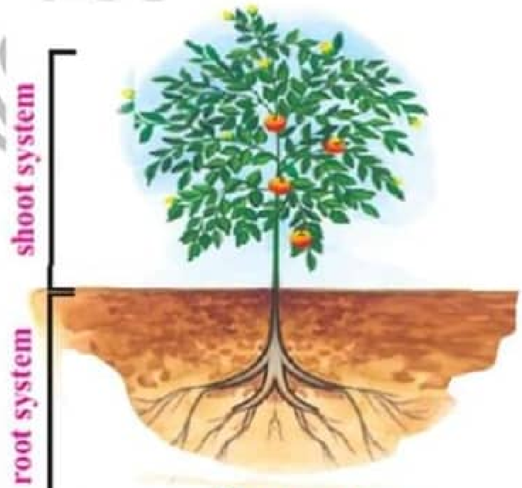
Liver
- Liver is an organ which helps in digestion of food.
- It also performs many other important functions. Like cells and tissues, organs also form groups.
- An **organ system** is a group of organs which work together.
- Different organ systems do one or more than one special functions.



Major Organ Systems in Plants
- Plants have two main organ systems; root system and shoot system.

Root System
- The root and its branches form the **root system** of a plant.
- Roots are present under the soil.
- Roots hold the plant in the soil.
- Root system helps the plant to absorb water and salts from the soil.

Shoot System
- The part of the plant outside the ground forms **shoot system**.
- It consists of main stem, leaves, branches and flowers.
- Shoot system performs many functions such as movement of water, food making and producing seeds, etc.



Plant systems

Major Human Organ Systems
- Many organ systems are present in a human body.
- These organ systems perform important functions.

Digestive System
- This organ system consists of mouth, food pipe, stomach, intestines and liver.
- It helps in digestion of food.

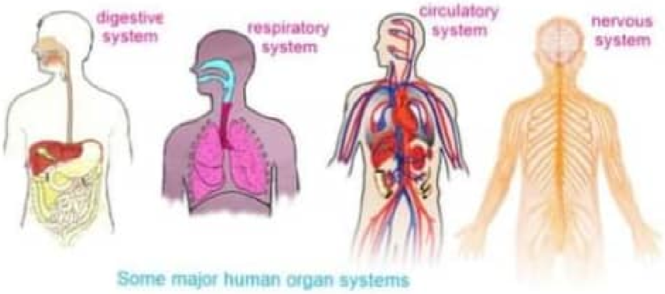
Respiratory System
- Respiratory system consists of nose, windpipe and lungs.
- We breathe through this organ system.

Circulatory System
- This organ system consists of heart and blood vessels. It circulates the blood within the body.
- The blood carries materials with it.

Nervous System
- Nervous system consists of brain, spinal cord and

nerves.

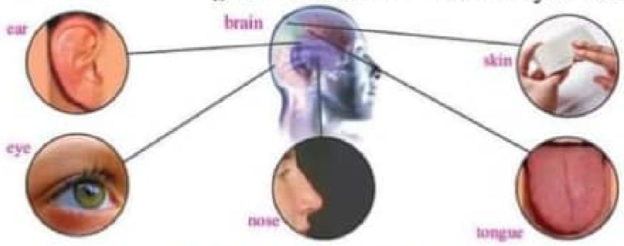
- It carries messages from one part of the body to the other



Some major human organ systems

CHAPTER 2 SENSE ORGANS

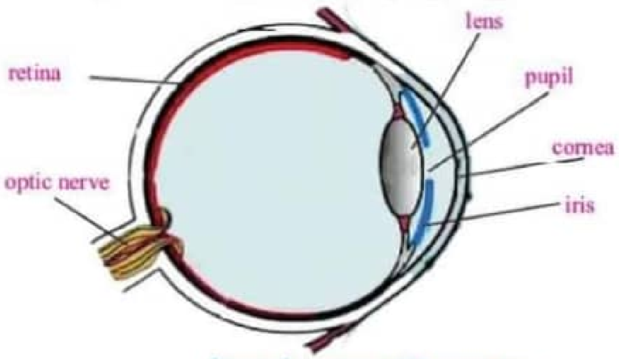
- Our eyes, ears, skin, nose and tongue are our sense organs.
- All the sense organs are linked to the brain by nerves.



Our brain controls every thing that our body does.

Eyes

- Our eyes tell us about colours, shapes and movements of objects around us.
- The eye is an organ of sight. T
- he human eye consists of an eyeball. The eye is covered with eyelids.
- Eyelashes on the eyelids keep away dust particles.
- Under the upper eyelids tear glands open.
- Main parts of our eye are cornea, iris, pupil, lens, retina and optic nerve



Internal structure of human eye

Cornea

- In the front of eye, the transparent part is called **cornea**.
- Light rays enter the eye through the cornea.

Iris

- Beneath the cornea the coloured portion of the eye is called **iris**.
- There is a hole in the middle of the iris, known as **pupil**.
- This pupil contracts in bright daylight and expands in dim light.

Lens

- Behind the pupil, a flexible **lens** is present.
- The lens helps the eye to focus light.

Retina

- The light sensitive portion of the eyeball is called **retina**.
- Eye lens forms the image on the retina.

Optic nerve

- When light hits the retina, its cells make nerve signals.
- These signals pass along the **optic nerve** to the brain.
- The lens in your eye can change its shape to see near and far objects.
- It becomes thick to see near objects. It becomes thin to see far objects.

Functioning of Eye

light rays → cornea → pupil → lens $\xrightarrow{\text{image}}$ retina $\xrightarrow{\text{optic nerve}}$ brain

- Our eye is similar to a camera. Both have lens. The lens in our eye forms image on the retina but camera lens forms an image on the film.

Ear

- We hear sounds through our ears.
- Ear is an organ of hearing.
- Human ear consists of three parts; outer ear, middle ear and inner ear.

Outer Ear

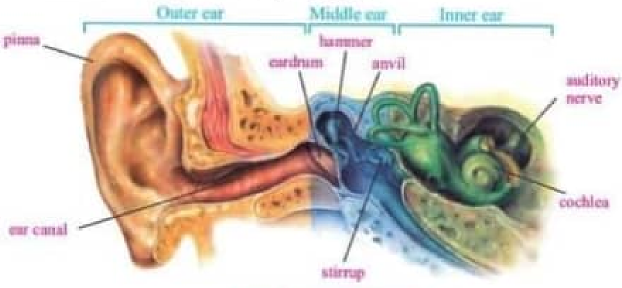
- The outer ear consists of a **pinna** and a long narrow tube called **ear canal**.
- The pinna collects sound waves from the air around.
- The sound waves then travel along the ear canal.

Middle Ear

- The outer ear is connected to the middle ear by a thin membrane called the **ear drum**.
- The eardrum vibrates when sound waves strike it.
- On the other side of the ear drum is the middle ear which is filled with air.
- It has three small bones in the body, i.e. **hammer, anvil** and **stirrup**.

Inner Ear

- The last part of the ear is the inner ear.
- The inner ear is filled with a liquid. This part of ear has a coiled structure called **cochlea**.
- The cochlea is the actual hearing organ.
- The cochlea sends signals to the brain through a special nerve called **auditory nerve**.

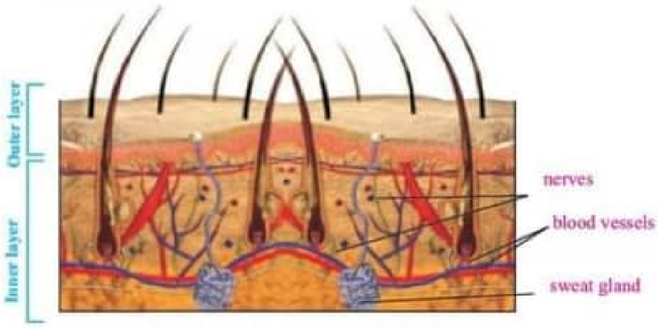


Internal structure of human ear

- Some animals can twitch their ears to catch sound waves.
- A horse can move its ears.

The Skin

- The largest sense organ in our body is the skin.
- Skin is the organ of touch. Skin covers every part of our body.
- skin protects the inner parts of our body.
- The skin contains several kinds of cells that detect pain, pressure, touch, heat and cold.
- Our skin has an outer layer and an inner layer.
- The **outer layer** has colour pigment and protects the skin from harmful rays of the Sun.
- The **inner layer** has blood vessels, nerves, sweat glands and roots of hairs.
- This layer is the sensitive part of the skin.
- When we touch something, sensitive cells of the skin receive messages and send them to the brain.
- "A blind person can read Braille, b y u s i n g t h e sense of touch".

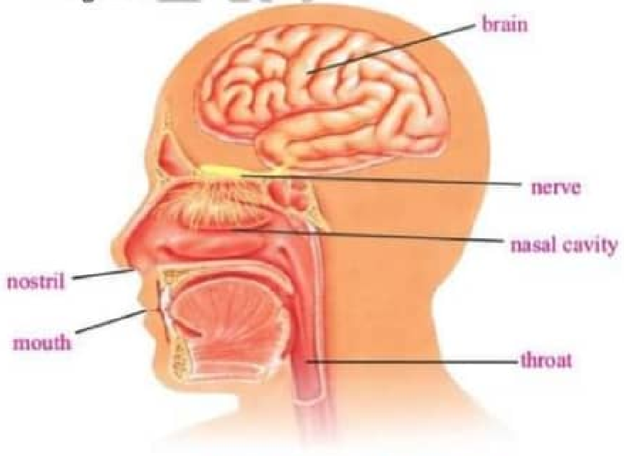


Internal structure of human skin

- "The skin at the tips of the fingers is most sensitive. The least sensitive part of our body is our heel."

The Nose

- Suppose there is a dead and decaying rat in one of your room's corners.
- The sense organ for smelling is the nose.
- Our nose is a hollow air passage. It has two openings called **nostrils**.
- In each side of the nose is an air chamber. The roof of the nose has lining of nerve cells to sense smell.
- When certain odour chemicals present in air enter our nose, they touch the nerve cells. Nerve cells pass the message to the brain through the **olfactory nerve**.
- Our brain tells whether the odour is pleasant or unpleasant.
- "Smells are tiny particles that breaks off the surface of things and float in the air."

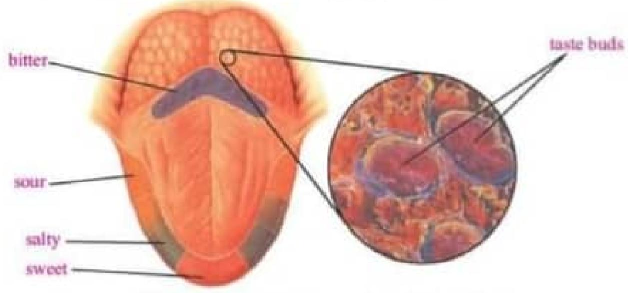


Internal structure of human nose

- Dogs have very strong sense of smell. They are often used to trace thieves and drugs.
- Our nose can detect 10,000 different scents and smells.
- Our sense of smell also helps our sense of taste.

The Tongue

- Our tongue is the sense organ of taste.
- It helps to detect the flavour of food.
- The upper surface of the tongue is covered with many pimple like lumps.
- Between these lumps, taste buds are present.
- Each taste bud has many nerve cells.
- When particles of a food touch the taste buds, nerves send signals of taste to the brain.
- The tip of the tongue has taste buds to detect sweet taste.
- The sides of the tongue are sensitive to salty and sour tastes.
- The back of the tongue has taste buds to detect bitter taste.



Different parts of the tongue detect different tastes.

CHAPTER 3
PHOTOSYNTHESIS AND RESPIRATION IN PLANTS

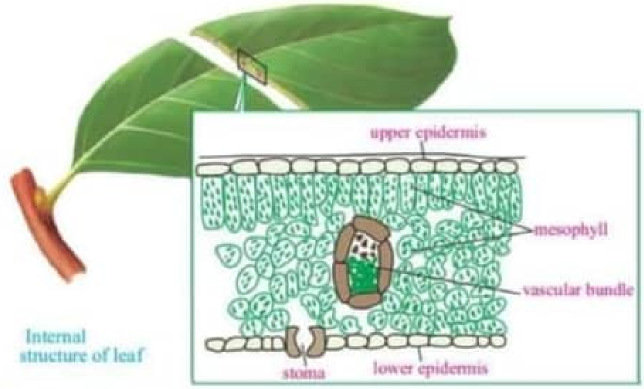
- All living things need energy to perform activities of life.
- Plants get energy from food which they prepare themselves.
- Two processes are very important for plants so that they may live alive. Food making process (Photosynthesis) and Energy producing process (Respiration)

Internal Structure of a Leaf

- Leaves are very important structures.
- They are plant's food factories.
- They absorb sunlight energy to make food. Under a powerful microscope, three main internal parts of a leaf, i.e. epidermis, mesophyll and vascular bundle.

Epidermis

- The upper layer of a leaf is called the **upper epidermis.**
- The lower layer of the leaf is called the **lower epidermis.**
- Lower epidermis has many **stomata**.
- Each stoma has an opening and two bean shaped guard cells.
- Exchange of oxygen, carbon dioxide and water vapours between the leaf cells and the air takes place through stomata.



Mesophyll

- Between the upper and lower epidermis is the mesophyll .
- The mesophyll is made of cells that contain **chloroplasts**.
- A green pigment chlorophyll is present in chloroplasts.
- Chlorophyll traps light energy which is used in food making process.
- The mesophyll is the region where food making process called **photosynthesis** takes place.

Vascular Bundle

- The central part of the mesophyll tissue is made of vascular bundle.
- Two types of tissues called xylem and phloem are present in vascular bundle **Xylem and phloem.**
- **Xylem** carries water from roots to the leaves.
- **Phloem** carries prepared food to other parts of a plant.
- The leaf looks green because the green colour of the chlorophyll shows through the clear epidermis. This chlorophyll helps to make food.
- When the guard cells absorb water, they swell and the stoma opens.
- When the guard cells release water, the stoma closes. Usually stomata remain open during the day and closed at night.

Photosynthesis

- The word "photosynthesis" is a combination of two Greek words: photo and synthesis. "Photo" means light, and "synthesis" means to make.
- Plants make their food using carbon dioxide and water in the presence of sunlight and chlorophyll. This process is called **photosynthesis**.
- During Photosynthesis, Plants also evolve oxygen during photosynthesis.
- A word equation can explain the process of photosynthesis.
- **Carbon dioxide + Water** $\xrightarrow[\text{chlorophyll}]{\text{sunlight}}$ **Glucose + Oxygen**

Importance of Photosynth

- Products of photosynthesis are glucose and oxygen.
  Effects of Different
- Light, temperature, carbon dioxide, water and chlorophyll are necessary factors for photosynthesis.

Light

- Plants trap sunlight to make food by photosynthesis.
- Photosynthesis increases as the light intensity increases.

Carbon dioxide

- Carbon dioxide which plants absorb from air is an essential component for photosynthesis.
- The rate of photosynthesis increases with increasing carbon dioxide level.
- The level of carbon dioxide in the air is about 0.03 to 0.04 percent.

Temperature

- The higher the temperature, the faster the process of photosynthesis.
- Normally plants grow well at 25–35°C.
- Temperatures below 0°C and above 40°C are not suitable for plant growth.

Water

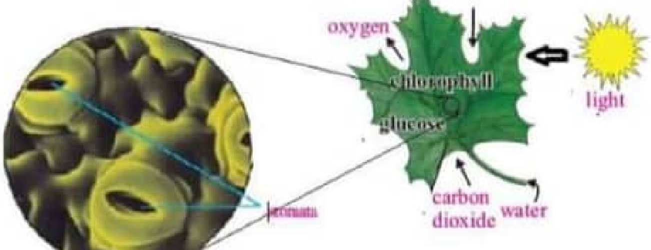
- Water is also one of the raw materials for photosynthesis and it is required in limited amounts.

Chlorophyll

- Chlorophyll is the green material in plants that traps sunlight for photosynthesis.
- It gives green colour to the leaves.
- Without chlorophyll the photosynthesis is impossible.
- "Plants is the world are sometimes called the "lungs of the nature".
- They produce oxygen and decrease carbon dioxide in the air."

Structure of Leaf is Well Suited to Photosynthesis

- Mostly photosynthesis occurs in green leaves because their structure is suitable for this process.
- Most leaves have a flat blade to absorb maximum light.
- Leaves are thin, so carbon dioxide and light can reach to inner cells easily.
- Leaves have large number of stomata in the lower epidermis.
- Carbon dioxide can enter and oxygen and water vapours leave through these stomata.
- Thick layer of mesophyll cells makes enough food for the plant.
- Vascular bundle in the leaf spreads its veins in a network to carry water to photosynthesizing cells and glucose away from them.
- All these characteristics prove that the structure of a leaf is fit for the process of photosynthesis.



Stomata are important for the gas-exchange process during photosynthesis!

Respiration In Plants

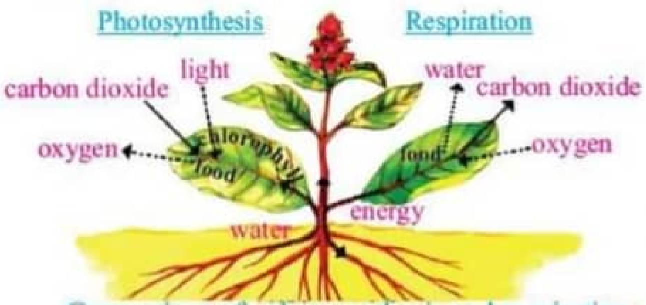
- Respiration is the energy producing process in living things.
- In this process plants use oxygen to break down glucose into water, carbon dioxide and energy.
- Glucose + Oxygen → C a r b on dioxide+ Water + Energy
- They use glucose and oxygen in respiration, while carbon dioxide and water are produced.
- These products are used in photosynthesis.

- At night the process of photosynthesis stops but respiration is a continuous process.
- Plants take in oxygen from the air and give out carbon dioxide and water in respiration.

Respiration takes place in the mitochondria of all cells.

Comparison Of Photosynthesis and Respiration

- Photosynthesis and respiration are two different processes. They are reverse to each other.



Comparison of photosynthesis and respiration

Photosynthesis	Respiration
Occurs in plants	Occurs in all living organisms
Food-making process	Food-using proces
Traps energy to produce glucose	Breaks glucose to release energy
Carbon dioxide+Water → Glucose+Oxygen	Glucose+Oxygen→ Carbon dioxide+Water+Energy
Photosynthesis occurs in chloroplasts of plant cells.	respiration occurs in mitochondria of every animal and plant cell.

CHAPTER 4 ENVIRONMENT AND INTEGRATION

Environment

- Everything around an organism that affects its life is called its **environment**.
- Life is not same on every part of the Earth.
- Conditions are different on different places. That is why, we find a variety of plants and animals on Earth.

Components of Environment

- Environment has two components Biotic and abiotic.
- All plants, animals and micro-organisms are called living or **biotic components** of an environment.
- Air, water, light, temperature and soil constitute non-living or **abiotic components** of an environment.

Biotic Components

- Biotic components of an environment consist of plants, animals and micro-organisms.

Producers

- Plants are able to make their own food by photosynthesis and are known as **producers**.
- They also release oxygen in which all organisms respire.

Consumers

- All the organisms which do not make their own food and feed on plants directly or indirectly are called **consumers**.
- There are different types of consumers. Animals that eat only plants are called **herbivores**.
- Horses, goats, squirrels and butterflies are herbivores.
- Animals that eat flesh of the herbivores or other animals are called **carnivores**.
- Some carnivores are tigers, lions, cats, dogs, frogs and snakes.
- Some animals eat both plants and animals. They are called **omnivores**.
- Chickens, crows, bears and humans are omnivores

A consumer may be a herbivore, a carnivore or an omnivore.

Decomposers

- When plants and animals die, their bodies are broken down or decomposed by bacteria and fungi. These bacteria and fungi are called **decomposers**.
- Decomposers play a very important role in the environment. They break down complex substances into simple ones.
- Plants and animals reuse these simple substances. This is a natural way of "recycling" of materials.

Dependence of Organisms Upon One Another

- All organisms (plants and animals) interact with each other.

Animals depend upon plants:

For food

  - All animals depend directly or indirectly on green plants for their food.

For shelter

- Some animals such as owls make their homes in the holes of trees.
- Some birds like sparrows, crows, eagles and kites build their nests in trees.
- A few insects like the ants, grasshoppers, moths and beetles live in trees.
- Plants provide animals shade and also make the surroundings cool.

For protection

- Some animals take help from plants to protect themselves from enemies.
- For example, a parrot hides in the green leaves due to its colour, a grasshopper hides in grass due to the same colour.

Plants also depend upon animals:

For carbon dioxide

- Plants cannot make their food without carbon dioxide gas.
- All animals release carbon dioxide during respiration. Plants absorb this gas from air.

For pollination

- Animals also help some plants in their pollination

Abiotic Components

- Abiotic components means non-living components.
- Light, temperature, soil, air and water are abiotic components in an environment.

Light

- Light is a very important abiotic factor of the environment.
- The ultimate source of light energy is the Sun.
- Plants need sunlight for photosynthesis.
- All animals use the food prepared by plants.
- Most animals including human beings need sunlight for most of their activities.

Temperature

- The heat of the Sun greatly influences the temperature of a place.
- Some places on the Earth like deserts are too hot and others like glaciers are too cold for animals and plants to survive.
- There is a great difference of temperature between day and night of a desert. Days are hot and nights are cold.
- Most organisms are active at temperatures between 0°C and 45°C.
- Temperature affects the activities of plants and animals.

Air

- Air is an important abiotic factor.
- Air is a mixture of gases. Air contains gases which are very important for the lives of animals and plants.
- Animals and plants respire in the oxygen of air.
- Respiration is a necessary process to live.
- Plants in addition to oxygen, also need carbon dioxide from air to make their food.

Soil

- Without soil, most of the plants would not exist.
- Plants get water and necessary minerals from soil.
- Bacteria present in soil provide important compounds to the plants.
- Man provides fertilizers to crops through soil.

Water

- Water is essential for life.
- It is present in the environment of every plant and animal.
- The amount of rainfall throughout the year determines the amount of water available at any place.
- A large number of plants and animals is found in tropical rainforests because of heavy rainfall.
- Very few plants and animals are found in deserts because of less rainfall.
- Many plants, such as water lily and hydrilla are found in water.
- Organisms living in deserts have developed special features to store water in their bodies.
- The cactus is a desert plant. Its fleshy body and spines help it to store water in its body.

Relationships Among Organisms

- There are many different types of relationships among organisms.

Predator-Prey Relationship

- An animal that kills and eats another animal is called a **predator**.
- The **prey** is the animal the predator kills and eats.
- The relationship between predator and prey is called **predation**.
- For example a lion hunts and eats Deer.The lion is a predator. The deer is its prey.
- Predation is a temporary relationship. It only lasts as long as the time a predator takes to kill and feed its prey.

Parasitism

- **Parasitism** is a relationship between two living organisms in which one is harmed and other helped.
- A **parasite** is a living organism that feeds on another living organism.
- The living organism on which the parasite feeds is called the **host**.
- Many plants and animals are parasites. A mosquito is a parasite.
- The mosquito uses our blood or the blood of another animal for food. We are the host and mosquito is a parasite.
- Cuscuta is a parasitic plant. Its weak and yellowish stem twines around the stem of the host plant. It sucks water and food from the stem.
- Leech, ascaris (malap), etc. are also parasites.

Mutualism

- **Mutualism** is a relationship in which two living organisms live together and depend on each other.
- It is a friendly relationship.
- Mutualism occurs among some plants and animals.
- Algae and fungi form lichen. The lichen shows mutualism between the two. Green alga makes food for itself and for the fungus. Fungus protects the alga from drying up. The fungus also gives carbon dioxide to alga to make food.
- A dead log contains termites. Termites eat wood. However, they are not able to digest the wood. There is a kind of a unicellular organism that lives inside the termites. This unicellular organism is able to digest the wood. After the unicellular organisms digest the wood, the termites can use it.

Some examples of mutualism

CHAPTER 5 ATOMS, MOLECULES, MIXTURES AND COMPOUNDS

- **All** things are made of **matter**.
- Matter is made of atoms.
- **Atom** is the smallest particle of matter which takes part in a chemical reaction.
- Atoms except noble gases cannot exist independently.
- Two or more atoms can join together to form larger particles of matter called **molecules**.
- Molecules can exist independently.
- Sometimes a molecule has the same kind of atoms but, sometimes, different atoms combine to form a molecule.
- For example, one molecule of oxygen gas is made of two similar oxygen atoms.
- A water molecule has three atoms, i.e. one oxygen atom and two hydrogen atoms.

Oxygen molecule (O_2) Water molecule (H_2O)

- The word 'atom' means 'indivisible'. But now the scientists have discovered that an atom is divisible. A
- toms are made of the fundamental particles called electrons, protons and neutrons. These particles are even smaller than the atoms.

Elements

- The matter consisting of only one kind of atoms is called an **element**.
- Gold, silver and copper are the examples of elements.
- Elements cannot be broken down into further simpler forms by ordinary chemical processes.

Every element consists of one kind of atoms.

- There are 109 elements known to scientists.
- Around 92 elements are naturally found. Other elements are made by scientists.
- Elements exist in all three states of matter.
- For example iron is a solid element.
- Mercury is a liquid element and oxygen is an element in gaseous state.

Some Common Elements an

- . Each element is given a symbol.
- A **symbol** is the abbreviated name of an element.
- The symbol consists of one or two letters taken from the English or Latin name of the element. 'H' is the symbol of hydrogen.'Na' is the symbol of sodium whose Latin name is *natrium*.

Element	Symbol	Element	Symbol
Aluminium	Al	Sulphur	S
Calcium	Ca	Iodine	I
Carbon	C	Nitrogen	N
Chlorine	Cl	Oxygen	O
Hydrogen	H	Phosphorous	P
Silver (Argentum)	Ag	Sodium (Natrium)	Na
Copper (Cuprum)	Cu	Mercury (Hydrargyrum)	Hg
Iron (Ferrum)	Fe	Gold (Aurum)	Au

Classification of Elements

- Scientists classify elements into two main groups, i.e. metals and nonmetals.

Metals

- About 70 percent elements are metals.
- All metals have similar properties.
- Most of the metals are shiny or gray solids and they can be moulded or shaped by heating and pressing.
- Metals are also good conductors of heat and electricity as they allow them to pass through.

Metal elements are used to make many objects.

Uses of Some Common Elements

Physical Properties and uses of Metals

- Metals are widely used in our everyday life due to their physical properties.

State

- Most metals are found in solid state.
- However, mercury (Hg) is found in liquid state.
- Mercury is filled in thermometers to measure temperature.

Hardness

- Most metals are hard solids. For example, iron is used to make steel.
- The steel is then used for making rails, bridges, ships, girders, surgical instruments and utensils.

Lustre

- Freshly cut metals have brilliant shine, called lustre.
- For example, aluminium is used for making utensils and picture frames due to its lustre.
- Gold and silver are used to make ornaments because of their shine.

Melting and Boiling Points

- Metals have high melting and boiling points.
- Due to this property iron, copper and aluminium are used to make kitchen utensils.

Strength and Malleability

- Metals are used to make sheets, wires and springs due to their property of strength and malleability.

Conductivity

- Metals like copper and aluminum are used in electrical wiring.
- They have the property to allow the electricity to pass through them. This property is called conductivity.

Alloys

- An interesting property of metals is the ability to form alloys.
- An alloy contains more than one metals.
- German silver is an alloy of copper, zinc and nickle.
- It is used in jewellery.
- Brass is the alloy of copper and zinc which is used to make pipes, hose nozzles and jewellery.

Physical Properties and Uses of Common Non-metals

- Non-metals are found in solid, liquid and gaseous states.
- Most nonmetals are not hard. Most non-metals have no shine or luster.
- They have low melting and boiling points. Most non-metals are bad conductors of electricity.
- However, graphite is a good conductor of electricity. Non-metals are widely used in our daily life.
- Air contains several gases, which are non-metal elements.
- Welders use flame of hydrogen and oxygen for cutting and welding metals.
- Hydrogen and nitrogen gases are used in the manufacture of urea (fertilizer).
- Banaspati ghee is manufactured by the use of hydrogen and vegetable oil.
- Phosphorous is used in match industry.
- Oxygen gas is used in hospitals.
- Carbon as diamond is used in jewellery.
- Graphite (carbon) is used by mixing with clay in pencils.
- Diamond (carbon) is a non-metal, but it is the hardest matter on the Earth. It is shiny and is used in jewellery. It is also used to cut glass.

Compounds and Mixtures

- Many things on the Earth are not elements.

Compounds

- When two or more elements combine chemically in a fixed ratio, a **compound** is formed.
- For example, water is the compound made of the elements hydrogen and oxygen.
- Hydrogen + Oxygen → Water
- There are 109 known elements but there are thousands of compounds.
- Elements in a compound cannot be separated easily.
- Properties of elements change when they are combined as compounds.
- In case of water, hydrogen and oxygen are colourless gases. They have no smell or taste. Hydrogen will burn very quickly in oxygen. Both of these gases combine to form water which is a compound. We can see and taste it.

Some common compounds of everyday use

Mixtures

- When two or more substances are mixed in such a way that no chemical change takes place, the combination is called a **mixture**.
- Parts of a mixture can be separated easily because they are not chemically combined.
- All the parts in a mixture keep their own properties.
- For example, salad in the bowl is a mixture of different fruits and vegetables.
- A mixture may be homogenous or heterogeneous.
- A **homogenous** mixture has uniform appearance throughout.
- For example, a mixture of sugar or salt dissolved in water.
- A **heterogenous** mixture does not have uniform appearance throughout. This mixture is made of different parts. For example, a mixture of oil and water.

Uses of Compounds and Mixtures

- . **Water** is used in homes, in industries and in agriculture. Without water life is impossible.
- **Carbon dioxide** is a compound of carbon and oxygen. Plants use it to make food. It is used to manufacture urea (fertilizer) and the bread. It is also filled in soda bottles.
- **Sodium chloride** is commonly known as table salt. It is the compound of sodium and chlorine elements. People use it to preserve fish and pickles. We add it to our food to make it salty. It is also used to manufacture caustic soda and washing soda.
- **Sherbat** is a mixture of sugar, water, table salt and lemon, etc. We use it in hot summer days.
- **Salad** is a mixture of different vegetables as onion, carrot, radish, beet, cucumber, tomato and cabbage, etc. **Ice cream** is a mixture of milk, sugar and flavour.
- **Milk** is also a mixture of water, fats, proteins and carbohydrates.
- **Tincture of iodine** is a mixture of iodine .
- The sea is the world's largest mixture. It covers about 70 percent of the Earth's surface.
- Water, sodium chloride (table salt) and many other salts are present in the sea water.and alcohol. We apply it on a cut to kill the germs.

Air as a Mixture of Gases

- Air is a mixture of gases.
- The largest component of air is nitrogen gas which is about 78 percent. 21 percent of air is the oxygen gas.
- Many other gases like carbon dioxide, helium, etc. form remaining one percent of air.
- Each gas in the air keeps its individual identity and can be separated. Besides gases, air also contains water vapour, particles of dust, smoke and pollen grains.

Level of Carbon dioxide in Air

- The amount of carbon dioxide (CO) in the air is 0.03 to 0.04 percent.
- All green plants use 2 this carbon dioxide to make their food during photosynthesis.
- All organisms evolve this gas during respiration. By the burning of wood, coal and oil, carbon dioxide is produced.

Separating Mixtures

Filtration

- **Filtration** is a method in which we use a filter paper or filter cloth to separate insoluble solids of a mixture from a liquid.
- We use strainer for separating tea leaves from tea. This is also a process of filtration.

- In a water filtration plant, filtration is used to separate solid impurities from dirty water.
- The hair and mucus in our nose help in the filtration of air before entering the lungs.
- Our kidneys filter the blood and separate waste materials in the form of urine.
- Water filters use the process of filtration to clean the tap water.

Sublimation

- The process in which a solid on heating, directly changes into gas or vapour state is called sublimation.
- Solid $\underset{\text{cooling}}{\overset{\text{heating}}{\rightleftharpoons}}$ Vapours
- Iodine, ammonium chloride (noshader), camphor (kafoor) and naphthalene have the property of sublime.

Distillation

- Mixtures can be separated with another method called distillation if the components of the mixture have different boiling points.
- **Distillation** is the method by which two or more liquids in solution are separated by boiling off the liquid with the lower boiling point and condensing it in another container.
- Crude oil is a mixture of different chemicals such as petrol, tar, oil, dissolved gases and kerosene.

Paper Chromatography

- Dyes and inks are mixed to make the colours for food, clothes and pens.
- **Chromatography** is the separation of coloured chemicals.
- In paper chromatography special paper is used to separate the coloured components in a mixture.
- Chromatography only works for soluble dyes, like that in food and pen, not the dyes in clothes.
- The most soluble dyes move faster on a filter paper than less soluble dyes.

CHAPTER 6 AIR

Air and its Importance

- Air is a mixture of gases.
- Air is present everywhere.
- Even in water and soil, air is present.
- Air covers the Earth like a thick blanket. This blanket of air is called the atmosphere.
- Many layers of air are present in the atmosphere.
- Scientists have divided the atmosphere into four layers. These are troposphere, stratosphere, mesosphere and thermosphere.
- Each layer of the atmosphere mixes with the layer above. Only the lowest layer of the atmosphere has enough air to support the life.
- Troposphere starts at Earth's surface and goes up about 8 kilometres to 16 kilometres above the surface. Most weather conditions happen in this layer.
- As we go up through the layers of the atmosphere, temperature and air pressure change.

Air is very important to us:

- We breathe in the air. We can't live without it.
- Air is needed for burning.
- We pump air into footballs, balloons and tyres of our vehicles.
- we use air pressure to draw dust into the bag of vacuum cleaner.
- Fish and other animals in water use the air dissolved in water for respiration.
- Plants use air (carbon dioxide) to make their food.
- Moving air is called wind. Differences in air temperature create winds. Winds can move slow or fast. Wind comes from different directions. A wind vane shows wind direction. Scientists make forecasting about weather with the help of a wind vane.

Composition of Air

- We know that air is a mixture of different gases. Major gases in the air are:
- About 78 percent of the air is nitrogen gas.
- About 21 percent of the air is oxygen gas.
- About 0.03 to 0.04 percent of the air is carbon dioxide gas.
- Remaining air contains rare gases like helium and argon.
- Some amount of water vapours, ozone, smoke and dust particles are also present in air

Properties and Uses of Gases in

Nitrogen

- Nitrogen is the major part of the air. It is a colourless gas.
- It has no taste or smell.
- It is slightly soluble in water.
- Nitrogen does not burn and does not support the process of burning. Actually, it is not a very active gas.

Uses of Nitrogen

- Nitrogen is used to preserve freshness of foods.
- As nitrogen does not burn, it is used in explosive storage tanks.
- Nitrogen is used in light bulbs to prevent the filament from burning up.
- Fertilizers like ammonia, urea, ammonium sulphate, contain nitrogen. These fertilizers increase the fertility of land.
- Nitrogen is used in dyes, medicines and explosives.
- Presence of nitrogen in the air reduces the process of rusting of iron.
- Liquid nitrogen is used as a coolant for freezing of blood and large computer systems.

Oxygen

- Second major gas of the air is oxygen. It is a colourless gas. It has no smell. Oxygen is slightly soluble in water. It is very active gas. Oxygen does not burn. But it helps in burning and rusting of iron.

Uses of Oxygen

- All the living organisms use oxygen for respiration.
- It is essential for burning of wood, coal and natural gas.
- It dissolves in water. Due to this property animals and plants breathe in the water.
- Some patients of lungs and heart diseases need oxygen in hospitals.
- Mountain climbers, sea divers and astronauts carry oxygen in cylinders for breathing.
- It is used in welding and cutting of metals.

Carbon Dioxide

- The amount of carbon dioxide in air is less than one percent.
- It is a colourless gas.
- It has no smell but a sour taste.
- It is slightly soluble in water but its solubility increases under high pressure.
- It is heavier than air. It can turn lime water milky.
- Carbon dioxide does not burn. It also does not support the burning process.

Uses of Carbon dioxide

- All green plants absorb carbon dioxide from the air to make food.
- Carbon dioxide is filled in soda water bottles under some pressure.
- A fire extinguisher releases carbon dioxide to put out fires.
- When the cake is baked, bubbles of carbon dioxide are given out. These bubbles cause the cake to rise and become fluffy.
- Carbon dioxide is easily frozen into its solid form which is called dry ice.

Rare Gases

- Rare gases include argon, neon, helium, etc.
- They do not react with other elements.
- They do not cause burning.
- They are present in rare amounts in air.

Uses of Rare Gases

- Argon is used in electric bulbs and fluorescent lamps.
- Neon is used in colourful advertisement lights.
- Helium is a very light gas. It is filled in weather balloons.

Water Vapours

- Very small amount of water vapours is also present in air. But the amount of water vapours in the air changes with changing weather.
- Heavy amount of water vapours in the air causes rain.
- Water vapours in the air control the rate of evaporation from plants and animals.
- The presence of water vapours in air sometimes produces smog which is a combination of smoke and fog.

Dust Particles

- Smoke and dust particles are also present in the air.
- We can see dust particles in the air

CHAPTER 7 SOLUTION AND SUSPENSION

- The sugar and the water mix so completely that the solid sugar seems to disappear.

Solution and its Components

- A **solution** is a homogenous mixture of two or more components.
- The mixture of salt and water is a solution. We use many solutions everyday.
- All solutions are the mixture of two or more substances.
- The substance in less amount is called **solute**.
- The substance in which solute is dissolved is called **solvent**. The solvent is always more in quantity than a solute.
- Solvent + Solute →Solution

Types of Solutions

- The most common types of solutions are those in which a solid, liquid or gas dissolves in a liquid.

Different Types of Solution		
Solute	Solvent	Example
Solid	Liquid	Salt solution, lemonade, tea
Liquid	Liquid	Ink in water, alcohol in water
Gas	Liquid	Carbonated drinks (carbon dioxide dissolved in water), River water (oxygen dissolved in water)
Gas	Gas	Air (mixture of many gases)
Solid	Solid	Brass (mixture of zinc and copper), bronze (mixture of copper and tin)

- The sea is the world's largest solution. Many salts are dissolved in sea water.

Aqueous Solution

- Water is the most common solvent in the world. It can dissolve many things in it and form solutions. However, grease, paint and fats do not dissolve in water.
- A solution in which water is the solvent is known as an **aqueous solution** (aqua means water).

Particle Model of Solution

- Matter exists in three states, i.e. solid, liquid and gas.

Solid

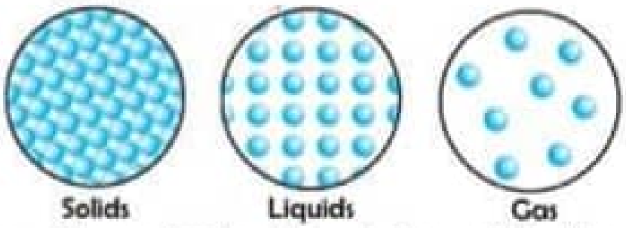
- Particles in a solid are held together strongly.
- There are very little spaces among them.
- Particles do not move freely.
- They only vibrate in their fixed position. That is why, a solid has a fixed shape and fixed volume.

Liquid

- Particles of a liquid are less close to each other than a solid.
- Spaces among the particles are greater than solids.
- Particles move freely and collide each other. But, particles do not leave the liquid. That is why, a liquid has fixed volume but no fixed shape.

Gas

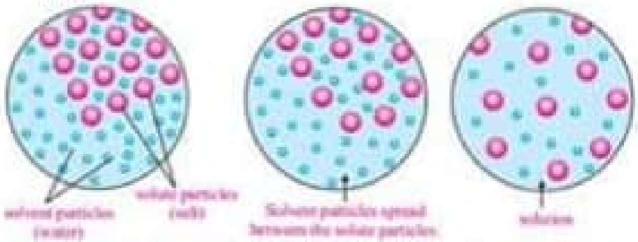
- There are large spaces among the particles of a gas.
- Particles move freely in the space they have.
- Particles may leave the gas, if it is not enclosed in a container. That is why, a gas has no fixed shape or volume.



- When we dissolve salt in water, forces of attraction between salt particles become weak. These particles of the salt spread among the spaces between water molecules. It is because of the constant motion of particles of water. Every part of the solution becomes same.
- When two liquids are mixed, their particles spread

among the spaces between particles of each other. In this way a homogenous solution is formed.

- For example, lemon juice makes solution with water.
- Some liquids do not make solution. Their particles do not spread among the spaces between particles of each other.
- For example, oil does not make solution with water.
- The temperature affects the movement of molecules. The greater the temperature, the faster the particles move.



Particles of the solute spread evenly throughout the solvent and form solution.

Water as a Universal Solvent

- Water is a very good solvent.
- Sugar, rock salt and sodium bicarbonate (meetha soda), etc. dissolve in water.
- Milk, alcohol, lemon juice, vinegar and apple juice dissolve in water.
- The food we eat forms a solution in the body and then absorbs in the blood.
- Many harmful substances are produced in our body. These substances dissolve in water and excrete as urine and perspiration.
- Plants absorb minerals from the soil that are dissolved in water.
- Oxygen gas dissolves in water. It keeps aquatic animals alive
- Carbon dioxide gas also dissolves in water. Aquatic plants use this dissolved carbon dioxide to make food.

Dilute and Concentrated Solution

- A solution with less quantity of a solute is called a dilute solution.
- A solution with more quantity of solute is called a concentrated solution.

Saturated and Unsaturated Solutions

- A solution in which the solvent cannot dissolve any more solute at a particular temperature is called a **saturated solution**.
- The Dead Sea is highly saturated with salts. These salts become crystals at slight decrease in temperature. Due to this property of The Dead Sea, things do not sink in it.

Solubility and Effect of Temperature

- **The amount of solute in grams dissolved in 100 grams of the solvent at a given temperature is called its solubility at that temperature.**
- the solubility of gases in liquid solvents decreases with increasing temperatures.

Some Uses of Solutions

- When sugar and water are mixed in such a way that sugar is dissolved evenly through the water, a **solution** is produced. We use many kinds of solutions.
- Carbonated water is a solution of carbon dioxide gas and other substances dissolved in water. When we shake a can of carbonated water, the gas separates quickly from the water.
- In a closed can, the bubbling gas has no place to go. It builds up pressure. When you open the can, the gas escapes.
- We use lemonade and tea in our homes. These are solutions too.
- The air is a solution of different gases. We breathe in this solution.
- The steel used for buildings and cars is a solution.
- A solution of two or more metals is called **alloy**.
- During the process of making steel, carbon and iron are melted into liquid form. Then the carbon is dissolved in the iron.
- In the ocean, salt and other minerals are dissolved in water.
- Ocean water is a solution.

Suspensions and Their Uses

- **A mixture in which the solute particles are too large to move freely with solvent particles and the particles settle down after some time, is called a suspension.**
- Mixing soil in water forms a suspension.
- Lassi is a form of suspension.
- Fruit squashes are examples of suspensions.
- Stirring up the bottom of a river or a lake produces a suspension. After some time, the sand or soil again settles down.
- Blood is a suspension. Red blood cells, white blood cells and platelets are suspended in a solution called plasma.
- A suspension which contains a large amount of insoluble solid solute is called **slurry**. The runny paste of cement mixed with water is an example of slurry.

Properties of Solutions and Suspensions	
Solution	**Suspensions**
Particles of solute do not settle out.	Particles of solute settle down on standing.
Particles pass through ordinary filter paper.	Particles can be separated by ordinary filter paper.
Light rays do not scatter on passing through the solution.	Light rays scatter on passing through the solution.

CHAPTER 8 ENERGY AND ITS FORM

- **Energy is the ability to do work.**

Forms of Energy

- Energy is found in different forms such as light, heat, chemical energy, etc. We can put all the forms of energy into two categories: potential and kinetic.

Potential Energy

- **Potential energy** is energy that is stored in an object

due to change in its position. It is written as P.E.

- When we stretch a rubber band or lift a stone to some height, energy is stored in these objects. This energy is called potential energy.
- A brick on the ground cannot do any work. But when we raise the same brick, energy is stored in it. The brick can do work due to the potential energy.
- The energy in the wound up spring of a toy car is potential energy. This energy can causes the toy car to move..
- The hands of a mechanical watch move due to the potential energy stored in its spring. There are several different forms of potential energy.

Chemical Energy

- Chemical energy is a form of potential energy. It is stored in foodbatteries and fuels such as coal, petrol and natural gas.
- Food, fuels and batteries release chemical energy as a result of chemical reactions.

Stored Mechanical Energy

- Mechanical energy is energy stored in the objects by the application of force.
- Compressed springs and stretched rubber bands possess stored mechanical energy.

Gravitational Energy

- Gravitational energy is energy stored in an object due to its height.
- When we raise a brick up to some height, it possesses gravitational energy.

Nuclear Energy

- Nuclear energy is energy stored in the nucleus of an atom. Very large amount of energy can be released when a nucleus of an atom splits.

Kinetic Energy

- Energy in a body due to its motion is called **kinetic energy.**
- A moving bus and running tap water possess kinetic energy. It is written as K.E.
- The amount of kinetic energy depends on the mass of the object and its speed.
- A train has more kinetic energy than a car moving at the same speed.
- The world is full of movement.
- Moving objects have kinetic energy.
- The moving air or wind has kinetic energy. It can move leaves and twigs of trees.
- Flowing water in a river can move things in it. It has kinetic energy. There are several other forms of energy.

Heat Energy

- Heat is a form of energy. It is the movement of particles with in the substance.
- When we heat up an object, its particles move and collide faster. Heat can move from one place to the other.
- Heat cooks our food. It changes solids into liquids and liquids into vapours. The Sun is a major source of heat for us.

Light Energy

- Light is a form of energy.
- The Sun is the major source of light for us.
- Light helps plants to make food. Some calculators use light energy to work.
- The light passing through the lens of a camera makes an image on the film.

Electrical Energy

- Electrical Energy is the movement of electrical charges.
- Electrical charges moving through a wire is called electricity.

Sound Energy

- Sound is also a form of energy. Sound energy is produced by the vibrating body.
- Place small pieces of paper on the surface of a stereo deck.
- The sound energy causes the pieces of paper to move.

Conversion of Different Forms of Energy

- Conversion of energy means energy changes.
- When we lift a toy car to the top of the ramp, potential energy is stored in it. When we let it go down the ramp, it moves and gains kinetic energy.
- Wood, natural gas, petrol, etc. all fuels have chemical energy (potential energy). When we burn these fuels, their energy changes to light and heat energy.
- When we switch on a bulb, the electrical energy changes into light energy.

In a bus

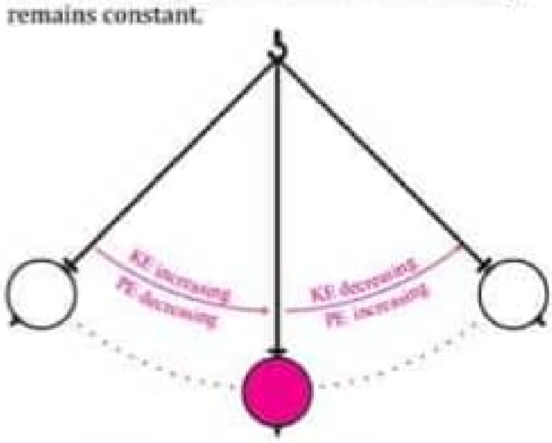
stored energy (potential energy) $\xrightarrow{\text{petrol}}$ moving energy (kinetic energy)

For a diver

stored energy (potential energy) $\longrightarrow$ moving energy (kinetic energy)

Conservation of Energy

- Energy cannot be made nor it can be destroyed but energy can be changed from one form to another. This fact is known as the **law of conservation of energy**.
- Consider a pendulum (a hanging ball) swinging back and forth. When the ball stops for a moment at the highest point in its swing, it has no kinetic energy. The energy is all potential. When it comes down at the lowest point on its swing, its speed is greatest. Here the pendulum has no potential energy. The energy is all kinetic. The pendulum keeps swinging, changing the forms of energy. But the total amount of energy remains constant.



- In case of pendulum in each swing, very small amount of its energy changes to heat energy which increases the temperature of the string and the ball. Heat dissipates in the atmosphere.

Energy Converters

- A **lamp** is an energy converter. It changes electrical energy to light energy.
- A **television** converts electrical energy to light energy (picture) and sound energy.
- A **radio** is a good example of energy converter. It changes electrical energy to sound energy.
- An **electric drill** is used to make holes in wood and metal. A drill converts electrical energy to mechanical energy (kinetic energy).
- **Washing machine** is a common energy converter which is used in our homes. It changes electrical energy to mechanical energy.
- A **calculator** with a cell converts electrical energy to light energy. Some calculators convert solar energy (from the sun) to electrical energy and then to light energy.

Renewable Energy Sources

- There are many sources of energy such as coal, oil and natural gas. These fuels are called **fossil fuels**.
- These fuels would not last forever. They are not recoverable. These sources are called **non-renewable energy sources**.
- Renewable sources of energy include wood, water, wind, animal wastes, sunlight and tides of sea.

Hydro-electric Energy

- The kinetic energy of flowing water is transformed into electrical energy. This energy is called as hydro-electric energy.
- Dams are built to obtain this energy. The water required for producing hydro-electric energy is available free of cost.
- Hydal power stations do not add pollution to atmosphere.

Wind Energy

- Wind has kinetic energy in it. A windmill is a machine which has blades. These blades move by the energy of wind. In recent years, a wind mill is being used to produce electricity.
- A wind farm (consists of about 100 windmills) is used to generate electricity in greater amount.
- Wind energy is available without any cost.
- Wind energy does not cause any pollution.

Biogas

- Biogas is a mixture of gases. These gases are formed by the decay of animal wastes and water.
- A biogas plant is used to produce this gas.
- Biogas can be used as a fuel in homes. We can use the remaining material as a fertilizer.
- The plant for biogas is also called gobar gas plant.
- Biogas is cheaper than any other fuel.
- It produces less pollution as compared to coal and petroleum.

Solar Energy

- The Sun is the ultimate source of energy on Earth.
- The energy coming from the Sun is called solar energy.
- Solar energy can be changed into electricity with the help of solar cells.
- Solar energy can be an effective renewable energy source in our country.
- Solar energy comes on the Earth free of cost.
- This energy is also pollution free.
- There is a lot of solar energy coming on the Earth.

Tidal Energy

- The winds when blow over the surface of the sea, cause tides in it. In some countries, these tides are used to make electricity.
- Energy from sea tides is also free of cost.
- This energy does not cause any type of pollution.

Energy in Our Lives

- Our body uses energy all the time; even when we sleep, our body requires energy.
- Our body needs energy to grow, to move and to keep warm.
- Our body gets energy from food. The food has stored energy.
- Our body changes this energy to the kinds of energy it needs, like heat energy and kinetic energy.

Energy Transfer in an Environment

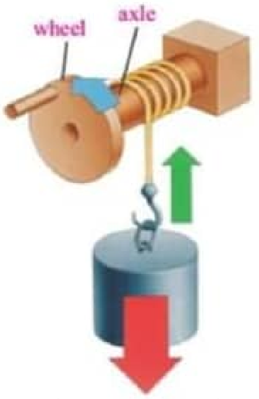
- Green plants use sunlight to grow and make food.
- This solar energy is stored in the form of chemical energy of food.
- Animals and human beings eat the food prepared by the plants.
- The chemical energy of food transfers to their bodies.
- The bodies of animals and human beings change the chemical energy of food to the kinds of energy they need.
- Heat energy and kinetic energy then dissipate in atmosphere. Similarly, solar energy causes wind energy, sea tides energy and many other forms of energy.
- All these energies change their form and at the end dissipate in atmosphere.

CHAPTER 9 FORCES AND MACHINES

- A machine is anything that makes our work simpler and easier.
- A **simple machine** is a simple tool used to make our work easier.
- Lever, wheel and axle, pulley, inclined plane, wedge and screw are simple machines.
- All the complex machines like tractors, cars and fans are made of simple machines.

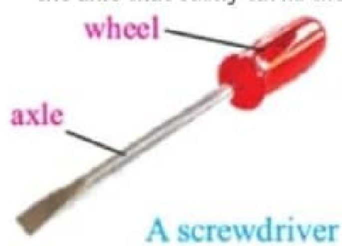
Wheel And Axle

- The most important invention of the human history is the "invention of the wheel". Wheels can move heavy objects easily. Wheels are used in a simple machine called wheel and axle.
- A **wheel and axle** consists of a large wheel fixed to a smaller wheel called the axle.
- When the wheel turns, the axle also turns.
- A wheel has bigger diameter than that of the axle.
- We use wheel and axle in two ways.
- To lift a heavy load , we apply force on the wheel to turn the axle. To increase the speed, we apply force on the axle to turn the wheel.

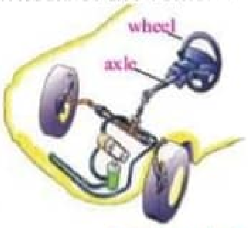


A wheel has bigger diameter than that of the axle

- A screwdriver is an example of wheel and axle.
- The broad part of the screwdriver works as a wheel. The narrow part of it acts as the axle.
- A small force on wheel provides a bigger force at the axle to push the screw into the wood.
- Also The steering wheel of motor vehicles is also an example of wheel and axle.
- A small force on steering wheel provides a big force to the axle that easily turns the wheels of the vehicle.



A screwdriver

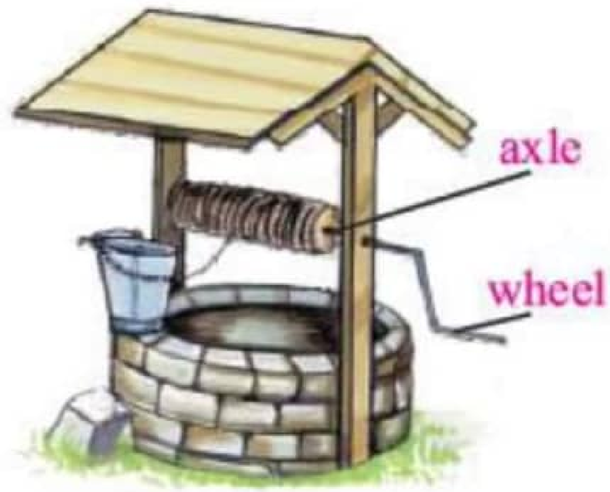


Steering wheel

- A mincing machine, a tap handle, a hand drill and crank on a well are examples of wheel and axle. Buses, cars and bicycles also contain wheels and axles.

A tap handle is a wheel.

The wheel and axle in this tricycle means it can roll smoothly along the ground.

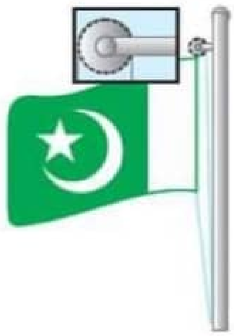


Pulley

- Instead of axle, the wheel could also rotate a rope or cord.
- This variation of the wheel and axle is the pulley.
- A **pulley** is the wheel with a groove in its edge through which a cord is passed.
- The pulley turns around an axle. We can use pulleys to raise and lower objects.

A pulley

- A pulley changes the direction of force and makes our work easier.
  - Pulley is used to lift construction material to upper stories on a construction site.
  - Motor mechanics and engineers use pulleys to lift and place heavy engines in the cars.
- The pulley on a flag-pole changes the direction of applied force.
- We pull down one end of the rope that passes over the pulley, the flag attached to the other end goes up.
  - A crane uses a pulley system in which fixed and moveable pulleys are used to lift very heavy loads.



Types of Pulley

- There are two kinds of pulleys, i.e. fixed pulley and moveable pulley.

Fixed Pulley

- The axle of this pulley is fixed with some support.
- The load is tied on one end of the rope which is passing over the pulley.
- The force is applied on the other end of the rope to lift the load.
- A fixed pulley is used to change the direction of applied force.

Moveable Pulley

- This kind of pulley has a hook to tie the load.
- The moveable pulley moves together with the load.
- In this kind, the rope is attached to some support while pulley moves.

- A moveable pulley does not change the direction of a force.
- The applied force and the load move in the same direction

Pulley System

- To make our work more easier, we can use pulley system.
- It consists of a fixed pulley and a moveable pulley. It is also called "block and tackle".
- The load is attached to the
- moveable pulley.

Fixed pulley Moveable pulley Pulley system

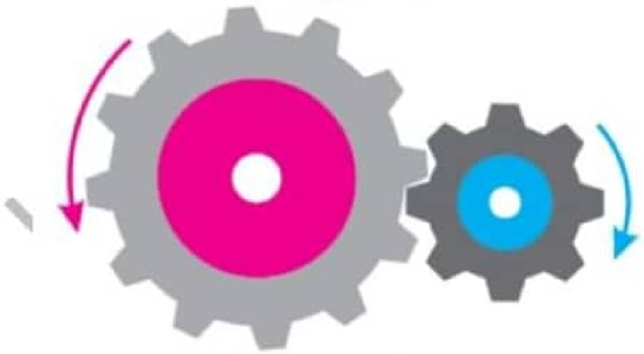
- Some times two pulleys work in such a way that they are connected with a belt. One pulley moves and causes the other pulley to move. For example in a water pump, a small pulley is attached to a motor. When motor runs the small pulley moves and causes the large pulley to move.

Gears

- A gear is also a modification of the wheel and axle.
- Gear wheel has teeth around it.
- The teeth of one gear usually fit into the teeth of another gear.
- Gears are used to transfer the force from one wheel to another.
- They can also increase or reduce the speed.

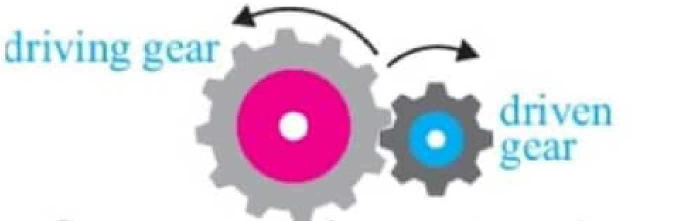
The Gear Train

- Gears work in teams. When two or more gears work together, it is called a **gear train** or gear system.
- One gear is called driving gear to which force is applied.
- The other gear is called driven gear which turns due to the movement of the first gear.



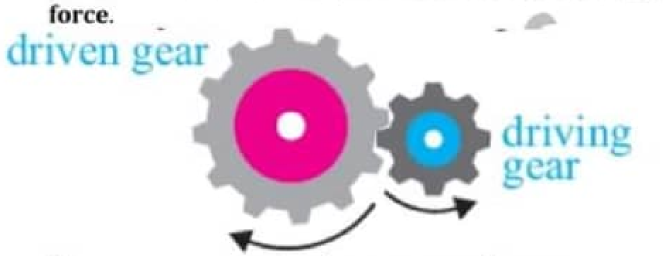
Gear train

- When the driving wheel is larger and the driven wheel is smaller, the gear system is used **to increase the speed**.



Gear system to increase speed

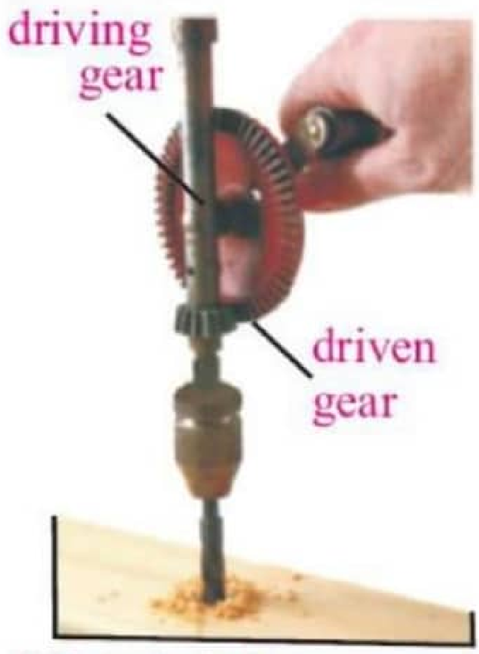
- When the driving wheel is smaller and the driven wheel is larger, the gear system is used **to increase the force**.



Gear system to increase force

Uses of Gears In Everyday

- Gears usually make part of a more complicated machine.
- They transfer energy from one wheel to the other to change the direction of force.
- A hand-drill consists of two mutually perpendicular gears. When its larger gear is rotated in a vertical plane, the smaller gear linked with it rotates very fast in the horizontal plane
- A hand-drill is used to make holes in wood.



A hand-drill

- Your bicycle moves with the help of gears. Two gears are linked with each other by a chain. The chain makes it possible for the small gear to move in the same direction as that of the big gear. The front gear is a large wheel with teeth in which pedal is fitted. The rear gear is a small toothed wheel which is present in the rear wheel of the bicycle. When you pedal the bicycle, you turn the big gear. The big gear turns the chain, which turns the rear small gear. When this small gear

turns, the bicycle moves forward. In a racing bicycle, more than two wheels work in the gear system.

- When a racer wants to increase the speed of a bicycle, he/she changes the gears or pulleys in such a way that the pedal gear is a larger wheel and the rear gear is the smallest wheel.
  - A wind-up clock consists of many gears. The minute wheel is a smaller gear with a few teeth, while the hour wheel is a bigger gear with many teeth. The minute wheel rotates the minute hand and hour wheel rotates the hour hand.

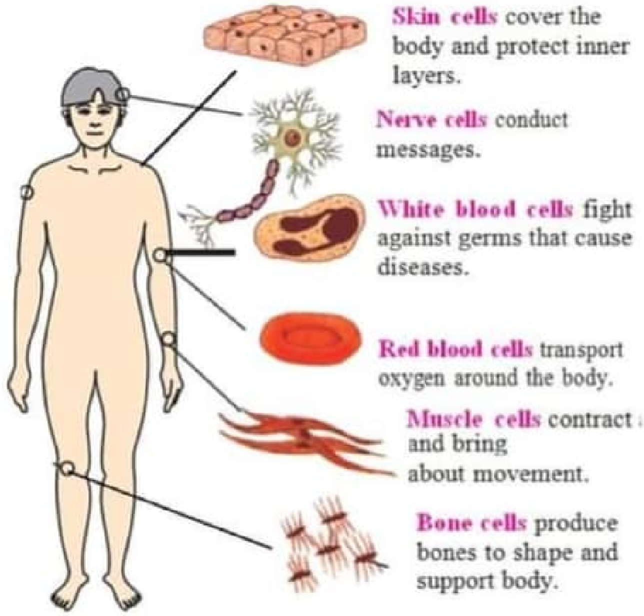
  - Gears are also used in motor vehicles, factory machines and many other instruments.

CLASS 6TH SCIENCE

CHAPTER 1 CELLULAR ORGANIZATIONOF PLANTS AND ANIMALS

Cells

All living organisms are made of cells. A cell is the basic unit of structureand function of all living organisms. Plants and animals are made of trillions ofcells. Some living organisms consist of only one cell, e.g. bacteria. Cells are different in sizes,shapesand functions



Different cells of our body perform different functions.

Some cells are large enough to be seen with the naked eye, e.g. yolk ofan egg. But most cells are too small. We cannot see them with our eyes. Weneed a special instrument to see thecells.

The term **"cell"** was first used by an Englishscientist Robert Hooke in 1665. He observedtiny box like structures in a thin slice ofa corkunder a microscope.

Microscope

Microscope is an instrument which is used to see very small things that cannot be seen with naked eye. When we look at something through a microscope, it appears larger. The microscopes we use in our schools are light microscopes. These microscopes use light to show the images.

A light microscope has a base, an arm, a tube, a stage and two adjustment screws. Two lenses are fitted on the two ends of the tube. The end of the tube through which we observe an object is called an eyepiece.

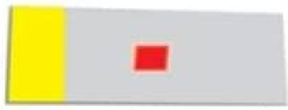
The lens near the object to be seen is called an objective lens. Light is passed through the object from below, using a mirror.

The object to be seen is placed on a glass slide and then on the stage. To focus the object clearly in the microscope, two adjustment screws are used.

We can view an object up to 1500 times bigger than its original size. Most of the cells are too small to be seen without a microscope.

A lightmicroscope

The slide is a rectangularpiece of glass. The objectis placed on it to observeunder the microscope.



Now-a-days scientists use electron microscopes to see very small objects inside the cell. An electron microscope can magnify the image up to 500,000 times. It shows clear images on a television screen. This microscope uses a beam of electrons instead of light.

Animal Cell and Plant Cell

Animal cells and plant cells are similar in many features but a few differences are also present.

There are many parts in a cell. A microscopic study of cells shows different parts in animal and plant cells

1. Cell Wall

The outermost covering of a plant cell is called the cell wall . It is made of a hard material, called cellulose. The cell wall supports the cell and gives it shape. Animal cells do not have a cell wall. Can you explain why a plant body is so hard and animal's body is not?

2. Cell Membrane

The outermost covering of an animal cell is called the cell membrane. In plant cells it is present next to the cell wall. The cell membrane controls the movement of materials in

and out of the cell.

3. **Cytoplasm**

Jellylike material present inside the cell membrane is called cytoplasm. It contains water and other chemical substances. Many cell organelles (tiny cell structures) are present in it. Most of the cell functions take place in cytoplasm.

CELL ORGANELLES

Endoplasmic reticulum:

It is a network of channels. The movement of materials in the cell takes place through the endoplasmic reticulum

Mitochondria: Mitochondria are cell parts that provide energy to the cell

Chloroplasts: Chloroplasts are parts of plant that contain chlorophyll. They trap energy from the Sun. Plants use the energy to make food

Vacuoles: Vacuoles store waste materials, water, air and food particles. In plant cells a single large vacuole is present, but in animal cells many small vacuoles are present.

Centrioles: Two centrioles are present near the nucleus of an animal cell. They play an important role in animal cell division.

Nucleus : The most important part of a cell is its **nucleus**. It controls all the activities of the cell. Therefore, a nucleus is the control centre of the cell. A thin membrane, called nuclear membrane, surrounds the nucleus. Many thread like structures called **chromosomes** are present in the nucleus. Chromosomes pass on the characteristics of the cell to new cells. The number of chromosomes is fixed in every cell. A human cell has 46 chromosomes.

Differences Between Plant and Animal Cells

Cell membrane, nucleus, mitochondria and endoplasmic reticulum, etc. are present in both plant and animal cells. But there are some differences too.

Plant Cell	Animal
Cell wall is present.	Cell wall is absent.
Nucleus lies near the side of the cell wall because of a large vacuole	Nucleus lies in the center of the cell
Single large vacuole is present	Many small vacuoles are present
Chloroplasts are present	Chloroplasts are absent
Centrioles are absent	Centrioles are present

Unicellular and Multicellular Organisms

Some living organisms are made of one cell and some are made of many cells. The living organisms made of only one cell are called **unicellular organisms**. Bacteria, chlamydomonas, amoeba and paramecium (Fig 1.5) are unicellular organisms.

The living organisms made of more than one cell are called **multicellular organisms**. Plants and animals which we see around us are multicellular organisms

Cells Form Tissues

In multicellular organisms, cells work in groups. A group of cells performing same function is called a **tissue**. Plants and animals have different tissues in their bodies.

Some Plant Tissues

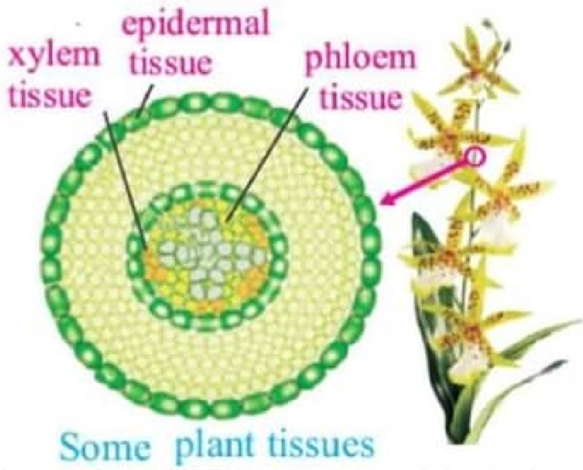
Following are some plant tissues

Epidermal tissue

Epidermal tissue covers the roots, stem and leaves of a plant.

Xylem tissue

Xylem tissue conducts water and dissolved salts from roots to the leaves.



Some plant tissues

Phloem tissue

Phloem tissue carries prepared food from leaves to other parts of plants. Mesophyll tissues present in leaves make food for the plant..

Some Animal Tissues

Following are some animal tissues

Muscle tissue

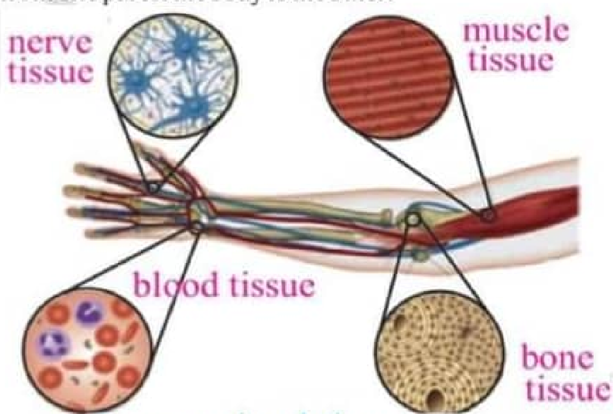
In an animal's body muscle cells for muscle tissues to help in movement.

Bone tissue

Bone tissue is formed by bone cells. This strong and solid tissue gives shape and support to the body.

Blood tissue

Blood cells form blood tissue. This tissue carries materials from one part of the body to the other.



Some animal tissues

Tissues Form Organs

Different tissues group together to form organs. Our body is made of a number of different organs such as the heart, lungs, eyes, brain, etc. An **organ** is made of different tissues which work together. An organ performs one or more than one functions.

Some Plant Organs

Following are some plant organs

Leaf

Plant leaf is an important organ. Leaves make food.

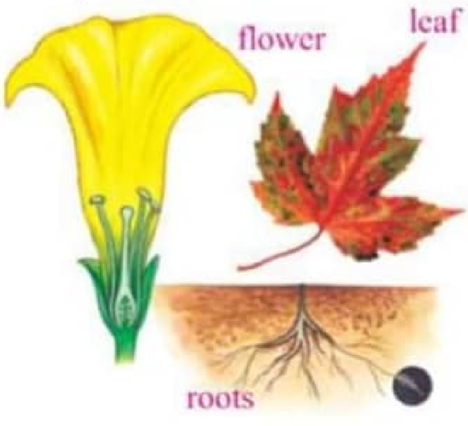
Flower

A flower is another important organ of the plants. Flowers produce seeds. Seeds grow to produce new plants.

Root

This organ holds the plant in the soil. Root also absorbs water and salts

for the plant.



Some plant organs

Some Animal Organs

Following are some animal organs

Heart

The heart pumps the blood in blood vessels which carry it to all parts of thebody.

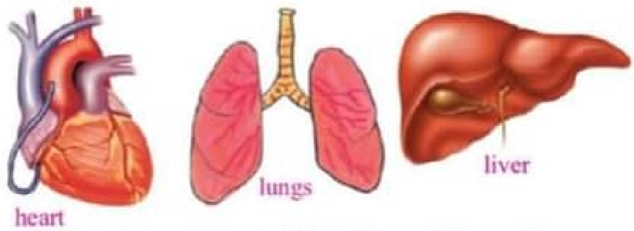
Tongue

Our tongue is an organ which tastesfood and helps in digestion offood.

Liver

Liver is an organ which helps in digestion of food. It also performs many other important functions. Like cells and tissues, organs also form groups.

An **organ system** is a group of organs which worktogether. Different organ systems do one or more than one special functions.



Some orans.

Major Organ Systems in Plants

Plants have two main organ systems; root system and shoot system.

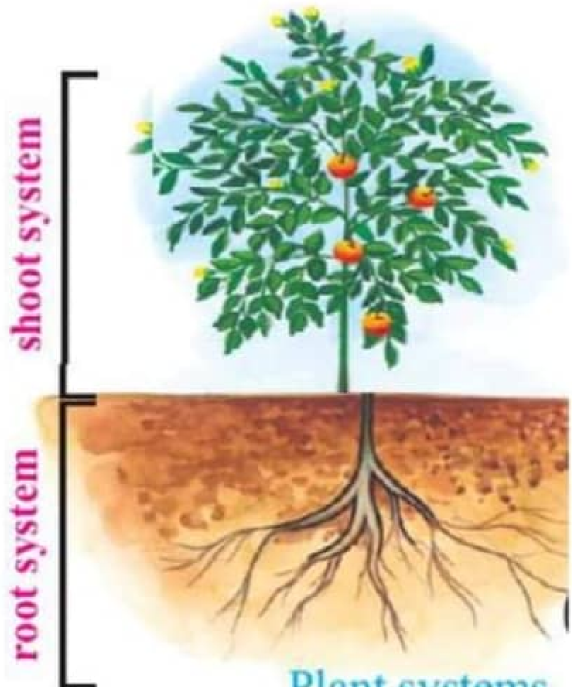
Root System

The root and its branches form the **root system** of a plant. Roots are present under thesoil. Roots hold the plant in the soil. Rootsystem helps the plant to absorb water and salts fromthe soil.

Shoot System

The part of the plant outside the ground forms **shoot system**. It consists of main stem,

leaves, branches and flowers. Shoot system performs many functions such as movement of water, food making and producingseeds, etc.



Plant systems

Major Human Organ Systems

Many organ systems are present in a human body. These organ systems perform important functions. Some major human organ systems are givenbelow.

Digestive System

This organ system consists of mouth, food pipe, stomach, intestines and liver. Ithelpsindigestionoffood.

Respiratory System

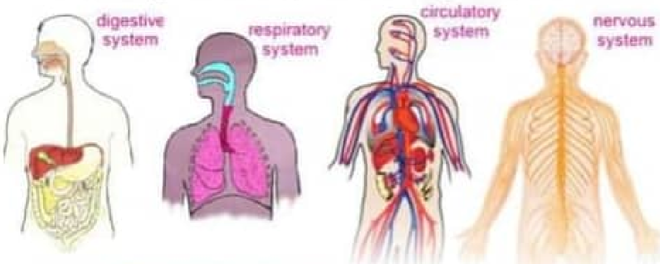
Respiratory system consists of nose, windpipe and lungs. We breathe throughthisorgansystem.

Circulatory System

This organ system consists of heart and blood vessels. It circulates the blood within the body. The blood carries materialswithit.

Nervous System

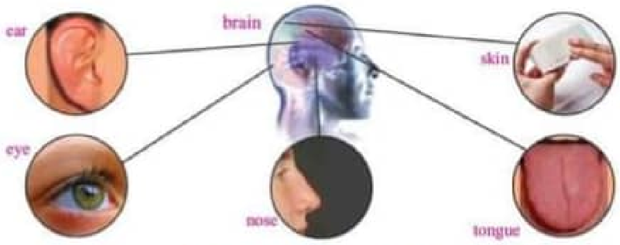
Nervous system consists of brain, spinal cord and nerves. It carries messagesfromonepartofthebodytotheother



Some major human organ systems

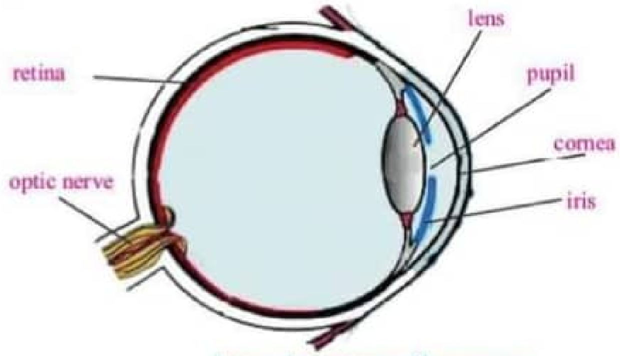
CHAPTER 2 SENSE ORGANS

The world around us is very interesting. Allah Almighty has blessed us with five sense organs to enjoy the world. Sense organs are special parts of our body that tell us what is going on around us. Our eyes, ears, skin, nose and tongue are our sense organs. All the sense organs are linked to the brain by nerves.



Our brain controls every thing that our body does.

We see with our eyes. Our eyes tell us about colours, shapes and movements of objects around us. The eye is an organ of sight. The human eye consists of an eyeball. The eye is covered with eyelids. Eyelashes on the eyelids keep away dust particles. Under the upper eyelids tear glands open.
Main parts of our eye are cornea, iris, pupil, lens, retina and optic nerve



Internal structure of human eye

Cornea
In the front of eye, the transparent part is called **cornea**. Light rays enter the eye through the cornea.

Iris
Beneath the cornea the coloured portion of the eye is called **iris**. There is a hole in the middle of the iris, known as **pupil**. This pupil contracts in bright daylight and expands in dim light.

Lens
Behind the pupil, a flexible **lens** is present. The lens helps the eye to focus light.

Retina
The light sensitive portion of the eyeball is called **retina**. Eye lens forms the image on the retina.

Optic nerve
When light hits the retina, its cells make nerve signals. These signals pass along the **optic nerve** to the brain.
The lens in your eye can change its shape to see near and far objects. It becomes thick to see near objects. It becomes thin to see far objects.

Functioning of Eye

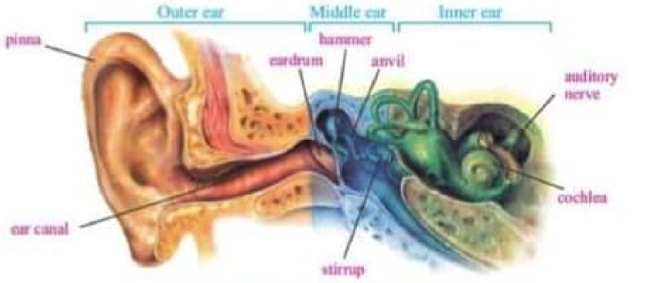
light rays → cornea → pupil → lens $\xrightarrow{\text{image}}$ retina $\xrightarrow{\text{optic nerve}}$ brain

Our eye is similar to a camera. Both have lens. The lens in our eye forms image on the retina but camera lens forms an image on the film.
We hear sounds through our ears. Ear is an organ of hearing. Human ear consists of three parts; outer ear, middle ear and inner ear.

Outer Ear
The outer ear consists of a **pinna** and a long narrow tube called **ear canal**. The pinna collects sound waves from the air around. The sound waves then travel along the ear canal.

Middle Ear
The outer ear is connected to the middle ear by a thin membrane called the **ear drum**. The eardrum vibrates when sound waves strike it. On the other side of the ear drum is the middle ear which is filled with air. It has three small bones in the body, i.e. **hammer, anvil** and **stirrup**.

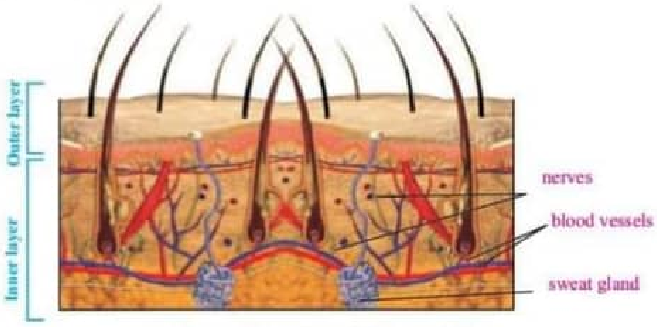
Inner Ear
The last part of the ear is the inner ear. The inner ear is filled with a liquid. This part of ear has a coiled structure called **cochlea**. The cochlea is the actual hearing organ. The cochlea sends signals to the brain through a special nerve called **auditory nerve**.



Internal structure of human ear

Some animals can twitch their ears to catch sound waves. A horse can move its ears. We can not move our ears.

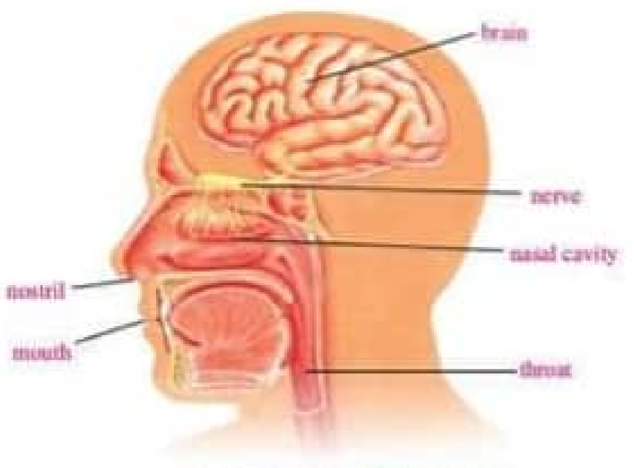
The Skin
The largest sense organ in our body is the skin. Skin is the organ of touch. Skin covers every part of our body. It protects the inner parts of our body. The skin contains several kinds of cells that detect pain, pressure, touch, heat and cold.
Our skin has an outer layer and an inner layer. The **outer layer** has colour pigment and protects the skin from harmful rays of the Sun. The **inner layer** has blood vessels, nerves, sweat glands and roots of hairs. This layer is the sensitive part of the skin. When we touch something, sensitive cells of the skin receive messages and send them to the brain.
"A blind person can read Braille, b y u s i n g t h e sense of touch".



Internal structure of human skin

"The skin at the tips of the fingers is most sensitive. The least sensitive part of our body is our heel."

The Nose
Suppose there is a dead and decaying rat in one of your room's corners. The sense organ for smelling is the nose.
Our nose is a hollow air passage. It has two openings called **nostrils**. In each side of the nose is an air chamber. The roof of the nose has lining of nerve cells to sense smell.
When certain odour chemicals present in air enter our nose, they touch the nerve cells. Nerve cells pass the message to the brain through the **olfactory nerve**. Our brain tells whether the odour is pleasant or unpleasant.
"Smells are tiny particles that breaks off the surface of things and float in the air."



Internal structure of human nose

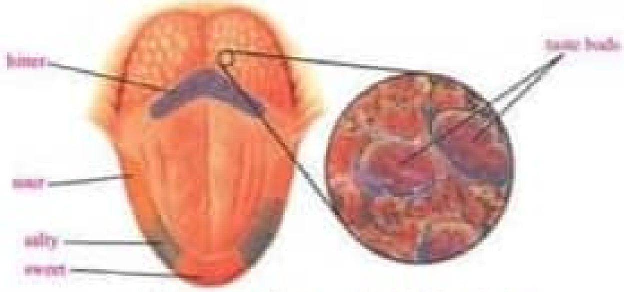
Dogs have very strong sense of smell. They are often used to trace thieves and drugs.

Our nose can detect 10,000 different scents and smells.

Our sense of smell also helps our sense of taste.

The Tongue

Our tongue is the sense organ of taste. It helps to detect the flavour of food. We can detect sweet, salty, sour and bitter tastes with our tongue. The upper surface of the tongue is covered with many pimple like lumps. Between these lumps, taste buds are present. Each taste bud has many nerve cells. When particles of a food touch the taste buds, nerves send signals of taste to the brain. We feel sweet, salty, sour and bitter tastes on different parts of our tongue. The tip of the tongue has taste buds to detect sweet taste. The sides of the tongue are sensitive to salty and sour tastes. The back of the tongue has taste buds to detect bitter taste.



Different parts of the tongue detect different tastes.

CHAPTER 3 PHOTOSYNTHESIS AND RESPIRATION IN PLANTS

All living things need energy to perform activities of life. You need energy to walk, talk, and play. Plants need energy too. Plants get energy from food which they prepare themselves. Two processes are very important for plants so that they may live alive.

1. Food making process (Photosynthesis)
2. Energy producing process (Respiration)

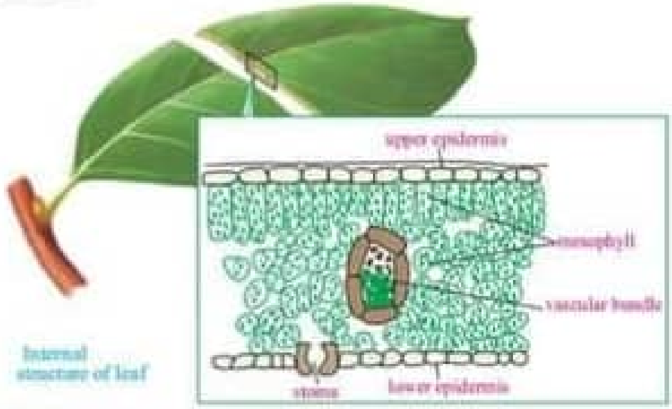
Before discussing photosynthesis and respiration, it will be very useful to study the internal structure of a leaf.

Leaves are very important structures. They are plant's food factories. They absorb sunlight energy to make food. Under a powerful microscope, we can see three main internal parts of a leaf, i.e. epidermis, mesophyll and vascular bundle.

Epidermis

The upper layer of a leaf is called the **upper epidermis.** The lower layer of the leaf is called the **lower epidermis.** Lower epidermis has many **stomata**.Each stoma has an opening and two bean shaped guard cells.

Exchange of oxygen, carbon dioxide and water vapours between the leaf cells and the air takes place through stomata.



Internal structure of leaf

Mesophyll

Between the upper and lower epidermis is the mesophyll .The mesophyll is made of cells that contain **chloroplasts**. A green pigment chlorophyll is present in chloroplasts. Chlorophyll traps light energy which is used in food making process. The mesophyll is the region where food making process called **photosynthesis** takes place.

Vascular Bundle

The central part of the mesophyll tissue is made of vascular bundle. Two types of tissues called xylem and phloem are present in vascular bundle. **Xylem** carries water from roots to the leaves. **Phloem** carries prepared food to other parts of a plant.

The leaf looks green because the green colour of the chlorophyll shows through the clear epidermis. This chlorophyll helps to make food.

When the guard cells absorb water, they swell and the stoma opens.When the guard cells release water, the stoma closes. Usually stomata remain open during the day and closed at night.

Photosynthesis

The word "photosynthesis" is a combination of two Greek words: photo and synthesis. "Photo" means light, and "synthesis" means to make.

Plants make their food using carbon dioxide and water in the presence of sunlight and chlorophyll. This process is called **photosynthesis**. Plants also evolve oxygen during photosynthesis.

A word equation can explain the process of photosynthesis.

Carbon dioxide + Water $\xrightarrow[\text{chlorophyll}]{\text{sunlight}}$ **Glucose + Oxygen**

Importance of Photosynth

Photosynthesis is one of the most important chemical changes that take place in our world. If photosynthesis did not take place, nearly all living things would die. Products of photosynthesis are glucose and oxygen. All the living things use both of these products in respiration to produce energy. This energy is used in performing activities of life.

Effects of Different

Light, temperature, carbon dioxide, water and chlorophyll are necessary

factors for photosynthesis. If any of these factors falls to a low level, photosynthesis

slows down or stops.

Light

Plants trap sunlight to make food by photosynthesis. Photosynthesis increases as the light intensity increases.

Carbon dioxide

Carbon dioxide which plants absorb from air is an essential component for photosynthesis. The rate of photosynthesis increases with increasing carbon dioxide level. The level of carbon dioxide in the air is about 0.03 to 0.04 percent.

Temperature

The higher the temperature, the faster the process of photosynthesis. Normally plants grow well at 25–35°C. Temperatures below 0°C and above 40°C are not suitable for plant growth.

Water

Water is also one of the raw materials for photosynthesis and it is required in limited amounts.

Chlorophyll

Chlorophyll is the green material in plants that traps sunlight for photosynthesis. It gives green colour to the leaves. Without chlorophyll the photosynthesis is impossible.

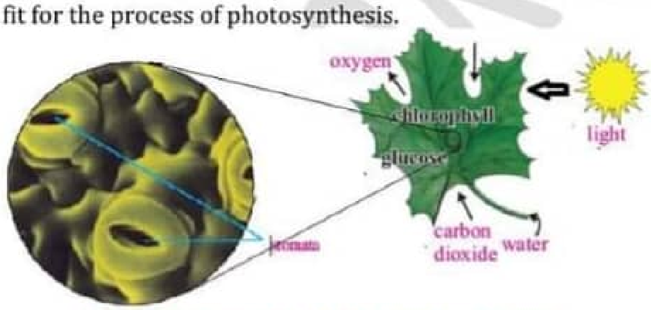
"Plants is the world are sometimes called the "lungs of the nature". They produce oxygen and decrease carbon dioxide in the air."

Structure of Leaf is Well Suited to Photosynthesis

Mostly photosynthesis occurs in green leaves because their structure is suitable for this process.

1. Most leaves have a flat blade to absorb maximum light.
2. Leaves are thin, so carbon dioxide and light can reach to inner cells easily.
3. Leaves have large number of stomata in the lower epidermis. Carbon dioxide can enter and oxygen and water vapours leave through these stomata.
4. Thick layer of mesophyll cells makes enough food for the plant.
5. Vascular bundle in the leaf spreads its veins in a network to carry water to photosynthesizing cells and glucose away from them.

All these characteristics prove that the structure of a leaf is fit for the process of photosynthesis.



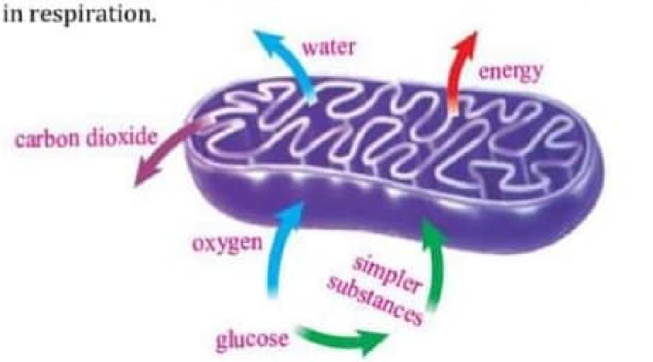
Stomata are important for the gas-exchange process during photosynthesis!

Respiration In Plants

Respiration is the energy producing process in living things. In this process plants use oxygen to break down glucose into water, carbon dioxide and energy. Here the word equation shows the process of respiration. Exchange of gases in plants takes place through stomata present in leaves.This exchange of gases takes place in two different steps. These steps are respiration and photosynthesis. During daytime plants photosynthesize and produce glucose and oxygen.

Glucose + Oxygen → C a r b on dioxide+ Water + Energy

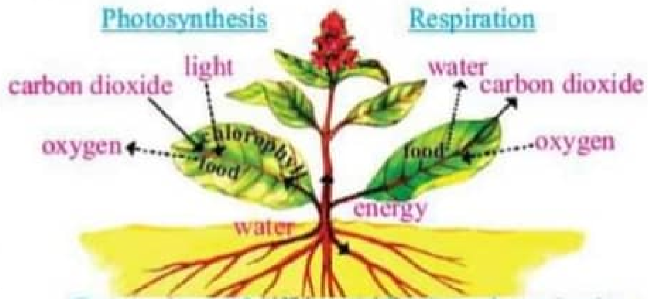
They use glucose and oxygen in respiration, while carbon dioxide and water are produced. These products are used in photosynthesis. At night the process of photosynthesis stops but respiration is a continuous process. Plants take in oxygen from the air and give out carbon dioxide and water in respiration.



Respiration takes place in the mitochondria of all cells.

Comparison Of Photosynthesis and Respiration

Photosynthesis and respiration are two different processes. They are reverse to each other.



Comparison of photosynthesis and respiration

Photosynthesis	Respiration
Occurs in plants	Occurs in all living organisms
Food-making process	Food-using proces
Traps energy to produce glucose	Breaks glucose to release energy
Carbon dioxide+Water → Glucose+Oxygen	Glucose+Oxygen→ Carbon dioxide+Water+Energy
Photosynthesis occurs in chloroplasts of plant cells.	respiration occurs in mitochondria of every animal and plant cell.

CHAPTER 4 ENVIRONMENT AND INTEGRATION

Environment

Everything around an organism that affects its life is called its **environment**. Life is not same on every part of the Earth. Conditions are different on different places. That is why, we find a variety of plants and animals on Earth. Living organisms do not live alone. All living things interact with one another all the time. They also interact with the non-living things around them.

Components of Environment

Environment has two components:

(1) All plants, animals and micro-organisms are called living or **biotic components** of an environment.

(2) Air, water, light, temperature and soil constitute non-living or **abiotic components** of an environment.

Biotic Components

Biotic components of an environment consist of plants, animals and micro-organisms.

Most of the interactions among organisms involve food. Plants and animals are often linked together because only green plants can make food.

Producers

Plants are able to make their own food by photosynthesis and are known as **producers**. They also release oxygen in which all organisms respire.

Consumers

All the organisms which do not make their own food and feed on plants directly or indirectly are called **consumers**.

There are different types of consumers. Animals that eat only plants are called **herbivores**. Horses, goats, squirrels and butterflies are herbivores.

Animals that eat flesh of the herbivores or other animals are called

carnivores. Some carnivores are tigers, lions, cats, dogs, frogs and snakes.

Some animals eat both plants and animals. They are called **omnivores**.

Chickens, crows, bears and humans are omnivores

A consumer may be a herbivore, a carnivore or an omnivore.

Decomposers

When plants and animals die, their bodies are broken down or decomposed by bacteria and fungi. These bacteria and fungi are called **decomposers**.

Decomposers play a very important role in the environment. They break down complex substances into simple ones. Plants and animals reuse these simple substances. This is a natural way of "recycling" of materials.

Dependence of Organisms Upon One

All organisms (plants and animals) interact with each other.

Animals depend upon plants:

1. For food

All animals depend directly or indirectly on green plants for their food.

2. For shelter

Some animals such as owls make their homes in the holes of trees. Some birds like sparrows, crows, eagles and kites build their nests in trees. A few insects like the ants, grasshoppers, moths and beetles live in trees. Plants provide animals shade and also make the surroundings cool.

3. For protection

Some animals take help from plants to protect themselves from enemies. For example, a parrot hides in the green leaves due to its colour, a grasshopper hides in grass due to the same colour.

Plants also depend upon animals:

1. For carbon dioxide

Plants cannot make their food without carbon dioxide gas. All animals release carbon dioxide during respiration. Plants absorb this gas from air.

2. For pollination

Animals also help some plants in their pollination

Abiotic Components

Abiotic components means non-living components. Light, temperature, soil, air and water are abiotic components in an environment.

Light

Light is a very important abiotic factor of the environment. The ultimate source of light energy is the Sun. Plants need sunlight for photosynthesis. All animals use the food prepared by plants. Most animals including human beings need sunlight for most of their

activities.

Temperature

The heat of the Sun greatly influences the temperature of a place. Some places on the Earth like deserts are too hot and others like glaciers are too cold for animals and plants to survive. There is a great difference of temperature between day and night of a desert. Days are hot and nights are cold. Most organisms are active at temperatures between 0°C and 45°C. Temperature affects the activities of plants and animals.

Air

Air is an important abiotic factor. Air is a mixture of gases. Air contains gases which are very important for the lives of animals and plants. Animals and plants respire in the oxygen of air. Respiration is a necessary process to live. Plants in addition to oxygen, also need carbon dioxide from air to make their food.

Soil

Soil is very important for plant growth. It is an important factor of environment.

Without soil, most of the plants would not exist. Plants get water and necessary minerals from soil. Bacteria present in soil provide important compounds to the plants. Man provides fertilizers to crops through soil.

Water

Water is essential for life. It is present in the environment of every plant and animal. The amount of rainfall throughout the year determines the amount of water available at any place.

A large number of plants and animals is found in tropical rainforests because of heavy rainfall. Very few plants and animals are found in deserts because of less rainfall. Many plants, such as water lily and hydrilla are found in water.

Organisms living in deserts have developed special features to store water in their bodies. The cactus is a desert plant. Its fleshy body and spines help it to store water in its body.

Relationships Among Organisms

Organisms in an environment interact with other organisms in order to obtain food, shelter, etc. There are many different types of relationships among organisms. Some of these are described below:

Predator-Prey Relationship

An animal that kills and eats another animal is called a **predator**. The **prey** is the animal the predator kills and eats. The relationship between predator and prey is called **predation**. For example a lion hunts and eats

Deer.The lion is a predator. The deer is its prey. Predation is a temporary relationship. It only lasts as long as the time

a predator takes to kill and feed its prey.

Parasitism

Parasitism is a relationship between two living organisms in which one is harmed and other helped. A **parasite** is a living organism that feeds on another living organism. The living organism on which the parasite feeds is called the **host**. Many plants and animals are parasites. A mosquito is a parasite. The mosquito uses our blood or the blood of another animal for food. We are the host and mosquito is a parasite. Cuscuta is a parasitic plant. Its weak and yellowish stem twines around the stem of the host plant. It sucks water and food from the stem. Leech, ascaris (malap), etc. are also parasites.

Mutualism

Mutualism is a relationship in which two living organisms live together and depend on each other. It is a friendly relationship. Mutualism occurs among some plants and animals.

Algae and fungi form lichen. The lichen shows mutualism between the two. Green alga makes food for itself and for the fungus. Fungus protects the alga from drying up. The fungus also gives carbon dioxide to alga to make food.

A dead log contains termites. Termites eat wood. However, they are not able to digest the wood. There is a kind of a unicellular organism that lives inside the termites. This unicellular organism is able to digest the wood. After the unicellular organisms digest the wood, the termites can use it.

Some examples of mutualism

CHAPTER 5 ATOMS, MOLECULES, MIXTURES AND COMPOUNDS

All things are made of **matter**. Matter is made of atoms. **Atom** is the smallest particle of matter which takes part in a chemical reaction. We cannot see atoms because they are so small. Atoms except noble gases cannot exist independently.

Two or more atoms can join together to form larger particles of matter called **molecules**. Molecules can exist independently. Sometimes a molecule has the same kind of atoms but, sometimes, different atoms combine to form a molecule. For example, one molecule of oxygen gas is made of two similar oxygen atoms. A water molecule has three atoms, i.e. one oxygen atom and two hydrogen atoms.

Oxygen molecule (O_2) Water molecule (H_2O)

The word 'atom' means 'indivisible'. But now the scientists have discovered that an atom is divisible. Atoms are made of the fundamental particles called electrons, protons and neutrons. These particles are even smaller than the atoms.

Elements

The matter consisting of only one kind of atoms is called an **element**. Gold, silver and copper are the examples of elements. Elements cannot be broken down into further simpler forms by ordinary chemical processes.

Every element consists of one kind of atoms.

There are 109 elements known to scientists. Around 92 elements are naturally found. Other elements are made by scientists. Elements exist in all three states of matter. For example iron is a solid element. Mercury is a liquid element and oxygen is an element in gaseous state.

Some Common Elements an

In the beginning, each element was written in its full name. A short way to write the names of elements was developed. Each element is given a symbol. A **symbol** is the abbreviated name of an element. The symbol consists of one or two letters taken from the English or Latin name of the element. 'H' is the symbol of hydrogen.'Na' is the symbol of sodium whose Latin name is *natrium*.

Element	Symbol	Element	Symbol
Aluminium	Al	Sulphur	S
Calcium	Ca	Iodine	I
Carbon	C	Nitrogen	N
Chlorine	Cl	Oxygen	O
Hydrogen	H	Phosphorous	P
Silver (Argentum)	Ag	Sodium (Natrium)	Na
Copper (Cuprum)	Cu	Mercury (Hydrargyrum)	Hg
Iron (Ferrum)	Fe	Gold (Aurum)	Au

Classification of Elements

Scientists classify elements into two main groups, i.e. metals and nonmetals.

Metals

About 70 percent elements are metals. All metals have similar properties. Most of the metals are shiny or gray solids and they can be moulded or shaped by heating and pressing. Metals are also good conductors of heat and electricity as they allow them to pass through.

Metal elements are used to make many objects.

Uses of Some Common Elements

We can relate the physical properties of elements to their uses.

Physical Properties and uses of Metals

Metals are widely used in our everyday life due to their physical properties.

I. State

Most metals are found in solid state. However, mercury (Hg) is found in liquid state. Mercury is filled in thermometers to measure temperature.

ii. Hardness

Most metals are hard solids. For example, iron is used to

make steel. The steel is then used for making rails, bridges, ships, girders, surgical instruments and utensils.

iii. Lustre

Freshly cut metals have brilliant shine, called lustre. For example, aluminium is used for making utensils and picture frames due to its lustre. Gold and silver are used to make ornaments because of their shine.

iv. Melting and Boiling Points

Metals have high melting and boiling points. Due to this property iron, copper and aluminium are used to make kitchen utensils.

v. Strength and Malleability

Metals are used to make sheets, wires and springs due to their property of strength and malleability.

vi. Conductivity

Metals like copper and aluminum are used in electrical wiring. They have the property to allow the electricity to pass through them. This property is called conductivity.

Alloys

An interesting property of metals is the ability to form alloys. An alloy contains more than one metals. German silver is an alloy of copper, zinc and nickle. It is used in jewellery. Brass is the alloy of copper and zinc which is used to make pipes, hose nozzles and jewellery.

Physical Properties and Uses of Common Non-metals

Non-metals are found in solid, liquid and gaseous states. Most nonmetals
are not hard. Most non-metals have no shine or luster. They have low
melting and boiling points. Most non-metals are bad conductors of electricity.

However, graphite is a good conductor of electricity. Non-metals are widely used
in our daily life.

1. Air contains several gases, which are non-metal elements.
2. Welders use flame of hydrogen and oxygen for cutting and welding metals.
3. Hydrogen and nitrogen gases are used in the manufacture of urea (fertilizer).
4. Banaspati ghee is manufactured by the use of hydrogen and vegetable oil.
5. Phosphorous is used in match industry.
6. Oxygen gas is used in hospitals.
7. Carbon as diamond is used in jewellery.
8. Graphite (carbon) is used by mixing with clay in pencils.

Diamond (carbon) is a non-metal, but it is the hardest matter on the Earth. It is shiny and is used in jewellery. It is also used to cut glass.

Compounds and Mixtures

Many things on the Earth are not elements. Some of them are compounds and some are mixtures.

Compounds

When two or more elements combine chemically in a fixed ratio, a **compound** is formed. For example, water is the compound made of the elements hydrogen and oxygen.

Hydrogen + Oxygen → Water

There are 109 known elements but there are thousands of compounds.

Elements in a compound cannot be separated easily. Properties of elements change when they are combined as compounds.

In case of water, hydrogen and oxygen are colourless gases. They have no smell or taste. Hydrogen will burn very quickly in oxygen. Both of these gases combine to form water which is a compound. We can see and taste it.

Some common compounds of everyday use

Mixtures

When two or more substances are mixed in such a way that no chemical change takes place, the combination is called a **mixture**.

Parts of a mixture can be separated easily because they are not chemically combined. All the parts in a mixture keep their own properties. For example, salad in the bowl is a mixture of different fruits and vegetables. You can taste them.

A mixture may be homogenous or heterogeneous. A **homogenous** mixture has uniform appearance throughout. For example, a mixture of sugar or salt dissolved in water. A **heterogenous** mixture does not have uniform appearance throughout. This mixture is made of different parts. For example, a mixture of oil and water.

Uses of Compounds and Mixtures

We use a number of compounds and mixtures in our everyday life. **Water** is used in homes, in industries and in agriculture. Without water life is impossible.

Carbon dioxide is a compound of carbon and oxygen. Plants use it to make food. It is used to manufacture urea (fertilizer) and the bread. It is also filled in soda bottles.

Sodium chloride is commonly known as table salt. It is the compound of sodium and chlorine elements. People use it to preserve fish and pickles. We add it to our food to make it salty. It is also used to manufacture caustic soda and washing soda.

Sherbat is a mixture of sugar, water, table salt and lemon, etc. We use it in hot summer days. **Salad** is a mixture of different vegetables as onion, carrot, radish, beet, cucumber, tomato and cabbage, etc. **Ice cream** is a mixture of milk, sugar and flavour. **Milk** is also a mixture of water, fats, proteins and carbohydrates. **Tincture of iodine** is a mixture of iodine .

The sea is the world's largest mixture. It covers about 70 percent of the Earth's surface. Water, sodium chloride (table salt) and many other salts are present in the sea water.and alcohol. We apply it on a cut to kill the germs.

Air as a Mixture of Gases

Air is a mixture of gases. The largest component of air is nitrogen gas which is about 78 percent. 21 percent of air is the oxygen gas. Many other gases like carbon dioxide, helium, etc. form remaining one percent of air. Each gas in the air keeps its individual identity and can be separated.Besides gases, air also contains water vapour, particles of dust, smoke and pollen grains.

Level of Carbon dioxide in Air

The amount of carbon dioxide (CO) in the air is 0.03 to 0.04 percent. All green plants use 2 this carbon dioxide to make their food during photosynthesis. Is it not strange that its level in the air is maintained at the above given ratio all the time? Nature has managed the level of carbon dioxide by different methods. All organisms evolve this gas during respiration. By the burning of wood, coal and oil, carbon dioxide is produced.

Separating Mixtures

4. Some patients of lungs and heart diseases need oxygen in hospitals.
5. Mountain climbers, sea divers and astronauts carry oxygen in cylinders for breathing.
6. It is used in welding and cutting of metals.

Carbon Dioxide

The amount of carbon dioxide in air is less than one percent. It is a colourless gas. It has no smell but a sour taste. It is slightly soluble in water but its solubility increases under high pressure. It is heavier than air. It can turn lime water milky. Carbon dioxide does not burn. It also does not support the burning process.

Uses of Carbon dioxide

1. All green plants absorb carbon dioxide from the air to make food.
2. Carbon dioxide is filled in soda water bottles under some pressure.
3. A fire extinguisher releases carbon dioxide to put out fires.
4. When the cake is baked, bubbles of carbon dioxide are given out. These bubbles cause the cake to rise and become fluffy.
5. Carbon dioxide is easily frozen into its solid form which is called dry ice.

Rare Gases

Rare gases include argon, neon, helium, etc. They do not react with other elements. They do not cause burning. They are present in rare amounts in air.

Uses of Rare Gases

1. Argon is used in electric bulbs and fluorescent lamps.
2. Neon is used in colourful advertisement lights.
3. Helium is a very light gas. It is filled in weather balloons.

Water Vapours

Very small amount of water vapours is also present in air. But the amount of water vapours in the air changes with changing weather. Heavy amount of water vapours in the air causes rain. Water vapours in the air control the rate of evaporation from plants and animals. The presence of water vapours in air sometimes produces smog which is a combination of smoke and fog.

Dust Particles

Smoke and dust particles are also present in the air. We can see dust particles in the air. Close all the doors and windows of your room during a sunny day. Let the sunlight enter the room through a small hole and see the dust particles.

CHAPTER 7 SOLUTION AND SUSPENSION

When dirt and water make a mixture, the dirt will slowly settle to the bottom. When solid sugar dissolves in a glass of water to make a mixture, the sugar will not settle to the bottom. The sugar and the water mix so completely that the solid sugar seems to disappear. Every part of this mixture is exactly the same as every other part. This is a special kind of mixture. We will discuss it in this chapter.

Solution and its Components

We know that many solids dissolve when they are put into liquids. When something dissolves, it forms a solution. A **solution** is a homogenous mixture of two or more components. The mixture of salt and water is a solution. We use many solutions everyday. All solutions are the mixture of two or more substances. The substance in less amount is called **solute**. The substance in which solute is dissolved is called **solvent**. The solvent is always more in quantity than a solute.

Solvent + Solute → Solution

Types of Solutions

The most common types of solutions are those in which a solid, liquid or gas dissolves in a liquid. However, other types of solutions are also found.

Different Types of Solution		
Solute	Solvent	Example
Solid	Liquid	Salt solution, lemonade, tea
Liquid	Liquid	Ink in water, alcohol in water
Gas	Liquid	Carbonated drinks (carbon dioxide dissolved in water). River water (oxygen dissolved in water)
Gas	Gas	Air (mixture of many gases)
Solid	Solid	Brass (mixture of zinc and copper), bronze (mixture of copper and tin)

The sea is the world's largest solution. Many salts are dissolved in sea water.

Aqueous Solution

Water is the most common solvent in the world. It can dissolve many things in it and form solutions. However, grease, paint and fats do not dissolve in water. A solution in which water is the solvent is known as an **aqueous solution** (aqua means water).

Particle Model of Solution

We know that matter consists of tiny particles.
These particles show special behaviour. A particle model explains the behaviour of particles of matter.

- The matter is made of tiny particles.
- Particles of matter are in constant motion.
- There are forces of attraction between particles.

There are spaces between the particles. On heating, the particles start moving faster.
Matter exists in three states, i.e. solid, liquid and gas. We can explain states of matter in the light of particle model.

1. Solid

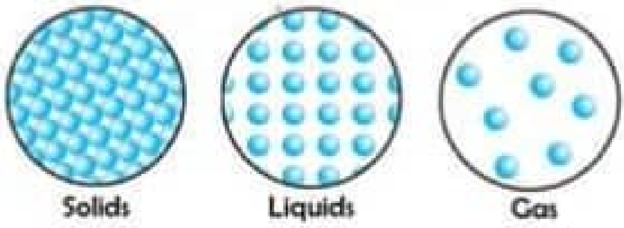
Particles in a solid are held together strongly. There are very little spaces among them. Particles do not move freely. They only vibrate in their fixed position. That is why, a solid has a fixed shape and fixed volume.

2. Liquid

Particles of a liquid are less close to each other than a solid. Spaces among the particles are greater than solids. Particles move freely and collide each other. But, particles do not leave the liquid. That is why, a liquid has fixed volume but no fixed shape.

3. Gas

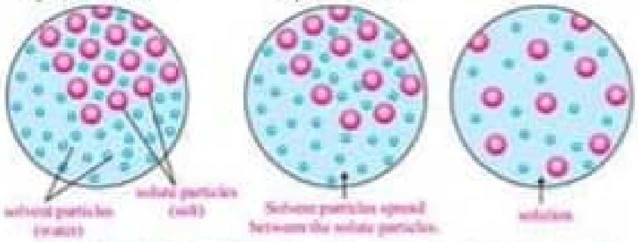
There are large spaces among the particles of a gas. Particles move freely in the space they have. Particles may leave the gas, if it is not enclosed in a container. That is why, a gas has no fixed shape or volume.



We can explain the formation of solution in the light of particle model of matter. When we dissolve salt in water,

forces of attraction between salt particles become weak. These particles of the salt spread among the spaces between water molecules. It is because of the constant motion of particles of water. Every part of the solution becomes same.

Liquid-liquid solution can also be explained in the light of particle model. When two liquids are mixed, their particles spread among the spaces between particles of each other. In this way a homogenous solution is formed. For example, lemon juice makes solution with water. Some liquids do not make solution. Their particles do not spread among the spaces between particles of each other. For example, oil does not make solution with water. The temperature affects the movement of molecules. The greater the temperature, the faster the particles move.



Particles of the solute spread evenly throughout the solvent and form solution.

Most of the things dissolve in water easily. We can say that water is a very
good solvent.

- Sugar, rock salt and sodium bicarbonate (meetha soda), etc. dissolve in water.
- Milk, alcohol, lemon juice, vinegar and apple juice dissolve in water.
- The food we eat forms a solution in the body and then absorbs in the blood.
- Many harmful substances are produced in our body. These substances dissolve in water and excrete as urine and perspiration.
- Plants absorb minerals from the soil that are dissolved in water.
- Oxygen gas dissolves in water. It keeps aquatic animals alive
- Carbon dioxide gas also dissolves in water. Aquatic plants use this dissolved carbon dioxide to make food.

Dilute and Concentrated Solution

A solution with less quantity of a solute is called a dilute solution. A solution with more quantity of solute is called a concentrated solution.

Solutions

A solution in which the solvent cannot dissolve any more solute at a particular temperature is called a **saturated solution**.

The Dead Sea is highly saturated with salts. These salts become crystals at slight decrease in temperature. Due to this property of The Dead Sea, things do not sink in it.

Solubility and Effect of Temperature

We can dissolve 24 grams of crystals of blue copper sulphate in 100 grams of water at room temperature to make saturated solution. But we have to dissolve 36 grams of table salt in 100 grams of water at room temperature to make it saturated solution. The difference is due to the different solubilities of these salts.

The amount of solute in grams dissolved in 100 grams of the solvent at a given temperature is called its solubility at that temperature.

Take 100 grams of water in a beaker and make a saturated solution of sodium chloride (table salt) at room temperature. Start heating the solution on a spirit lamp. Now add some more salt in the solution and stir it. You will see that more amount of salt is dissolved in this hot solution. It means the solubility of a solute increases with increase in temperature. We have learnt that 24 grams of copper sulphate dissolve in 100 grams of water at room temperature (25°C). At 60°C, 60 grams of copper sulphate will dissolve to make saturated solution. You can say that the solubility of copper sulphate is 24 grams at 25°C and 60 grams at 60°C. It is interesting that the solubility of gases in liquid solvents decreases with
increasing temperatures.

Some Uses of Solutions

When sugar and water are mixed in such a way that sugar is dissolved evenly through the water, a **solution** is produced. We use many kinds of solutions.

1. Carbonated water is a solution of carbon dioxide gas and other substances dissolved in water. When we shake a can of carbonated water, the gas separates quickly from the water. In a closed can, the bubbling gas has no place to go. It builds up pressure. When you open the can, the gas escapes.
2. We use lemonade and tea in our homes. These are solutions too.
3. The air is a solution of different gases. We breathe in this solution.
4. The steel used for buildings and cars is a solution. A solution of two or more metals is called **alloy**. During the process of making steel, carbon and iron are melted into liquid form. Then the carbon is dissolved in the iron.
5. In the ocean, salt and other minerals are dissolved in water. Ocean water is a solution.

Suspensions and Their Uses

When powdered chalk and water are mixed, a suspension is produced. The chalk spreads evenly through the water on shaking. When you stop shaking, the chalk settles down. This suspension has milky appearance because the chalk particles are visible.

A mixture in which the solute particles are too large to move freely with solvent particles and the particles settle down after some time, is called a suspension.

A suspension can be separated by passing it through a filter. The liquid or gas passes through, but the filter paper traps the large solid particles. Here are some examples of suspensions.

- Mixing soil in water forms a suspension.
- Lassi is a form of suspension.
- Fruit squashes are examples of suspensions.
- Stirring up the bottom of a river or a lake produces a suspension. After some time, the sand or soil again settles down.
- Blood is a suspension. Red blood cells, white blood cells and platelets are suspended in a solution called plasma.
- A suspension which contains a large amount of insoluble solid solute is called **slurry**. The runny paste of cement mixed with water is an example of slurry.

Properties of Solutions and Suspensions	
Solution	Suspensions

Particles of solute do not settle out.	Particles of solute settle down on standing.
Particles pass through ordinary filter paper.	Particles can be separated by ordinary filter paper.
Light rays do not scatter on passing through the solution.	Light rays scatter on passing through the solution.

CHAPTER 8 ENERGY AND ITS FORM

Energy makes change possible. We use it while doing things. It moves cars along the road and boats over the water. It cooks our food and keeps ice frozen in the freezer. It plays our favourite
songs on the radio and lights our homes. Energy is needed for our bodies to grow. Scientists define energy as:
Energy is the ability to do work.

Forms of Energy

Energy is found in different forms such as light, heat, chemical energy, etc. We can put all the forms of energy into two categories: potential and kinetic.

1. Potential Energy

Potential energy is energy that is stored in an object due to change in its position. It is written as P.E. When we stretch a rubber band or lift a stone to some height, energy is stored in these objects. This energy is called potential energy. A brick on the ground cannot do any work. But when we raise the same brick, energy is stored in it.
The brick can do work due to the potential energy. The energy in the wound up spring of a toy car is potential energy. This energy can causes the toy car to move.
When we put a stone in the sling of a catapult and stretch its rubber, potential energy stores in it.
This energy can throw away the stone.
The hands of a mechanical watch move due to the potential energy stored in its spring. There are several different forms of potential energy.

Chemical Energy

Chemical energy is a form of potential energy. It is stored in foodbatteries and fuels such as coal, petrol and natural gas. Food, fuels and batteries release chemical energy as a result of chemical reactions.

Stored Mechanical Energy

Mechanical energy is energy stored in the objects by the application of force. Compressed springs and stretched rubber bands possess stored mechanical energy.

Gravitational Energy

Gravitational energy is energy stored in an object due to its height. When we raise a brick up to some height, it possesses gravitational energy.

Nuclear Energy

Nuclear energy is energy stored in the nucleus of an atom. Very large amount of energy can be released when a nucleus of an atom splits.

2. Kinetic Energy

Energy in a body due to its motion is called **kinetic energy.** A moving bus and running tap water possess kinetic energy. It is written as K.E. The amount of kinetic energy depends on the mass of the object and its speed. A train has more kinetic energy than a car moving at the same speed. The world is full of movement. Moving objects have kinetic energy. The moving air or wind has kinetic energy. It can move leaves and twigs of trees. Flowing water in a river can move things in it. It has kinetic energy. There are several other forms of energy.

Heat Energy

Heat is a form of energy. It is the movement of particles with in the substance. When we heat up an object, its particles move and collide faster. Heat can move from one place to the other. Heat cooks our food. It changes solids into liquids and liquids into vapours. The Sun is a major source of heat for us.

Light Energy

Light is a form of energy. The Sun is the major source of light for us. Light helps plants to make food. Some calculators use light energy to work. The light passing through the lens of a camera makes an image on the film.

Electrical Energy

Electrical Energy is the movement of electrical charges. Electrical charges moving through a wire is called electricity. We use many appliances at homes which use electricity. Can you name such appliances? Lightning is another example of electrical energy.

Sound Energy

Sound is also a form of energy. Sound energy is produced by the vibrating body. Place small pieces of paper on the surface of a stereo deck. The sound energy causes the pieces of paper to move. When you speak, your sound vibrates the eardrums of your friend. The energy in sound is far less than other forms of energy.

Conversion of Different Forms of

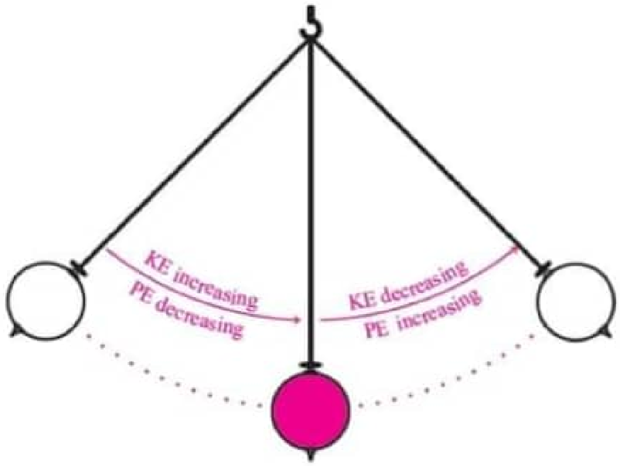
Conversion of energy means energy changes. One form of energy can be changed into another form. Let us discuss some energy changes.
1. When we lift a toy car to the top of the ramp, potential energy is stored in it. When we let it go down the ramp, it moves and gains kinetic energy.
2. Wood, natural gas, petrol, etc. all fuels have chemical energy (potential energy). When we burn these fuels, their energy changes to light and heat energy.
3. When we switch on a bulb, the electrical energy changes into light energy.

In a bus
stored energy (potential energy) $\xrightarrow{\text{petrol}}$ moving energy (kinetic energy)

For a diver
stored energy (potential energy) → moving energy (kinetic energy)

Conservation of Energy

About a hundred years ago, a few scientists performed some experiments. They concluded that: Energy cannot be made nor it can be destroyed but energy can be changed from one form to another. This fact is known as the **law of conservation of energy**. Consider a pendulum (a hanging ball) swinging back and forth. When the ball stops for a moment at the highest point in its swing, it has no kinetic energy. The energy is all potential. When it comes down at the lowest point on its swing, its speed is greatest. Here the pendulum has no potential energy. The energy is all kinetic. The pendulum keeps swinging, changing the forms of energy. But the total amount of energy remains constant.



When after a long time the pendulum stops its swinging, what happens to its energy? Is this energy lost? No, according to the law of conservation of energy, the energy cannot be made or destroyed. It simply changes its form. In case of pendulum in each swing, very small amount of its energy changes to heat energy which increases the temperature of the string and the ball. Heat dissipates in the atmosphere.

Energy Converters

Energy can change its form. Scientists have developed such devices which change the form of energy. These devices are called **energy converters** or **energy changers**. We use many energy converters in our everyday life.

i. A **lamp** is an energy converter. It changes electrical energy to light energy.

ii. A **television** converts electrical energy to light energy (picture) and sound energy.

iii. A **radio** is a good example of energy converter. It changes electrical energy to sound energy.

iv. An **electric drill** is used to make holes in wood and metal. A drill converts electrical energy to mechanical energy (kinetic energy).

v. **Washing machine** is a common energy converter which is used in our homes. It changes electrical energy to mechanical energy.

vi. A **calculator** with a cell converts electrical energy to light energy. Some calculators convert solar energy (from the sun) to electrical energy and then to light energy.

Renewable Energy Sources

There are many sources of energy such as coal, oil and natural gas. These fuels are called **fossil fuels**. These fuels would not last forever. They are not recoverable. These sources are called **non-renewable energy sources**. The shortage of fossil fuels will create serious energy problems. We must look for alternative sources of energy that can be recovered. These sources are called **renewable energy sources**. Renewable sources of energy include wood, water, wind, animal wastes, sunlight and tides of sea.

Hydro-electric Energy

The kinetic energy of flowing water is transformed into electrical energy. This energy is called as hydro-electric energy. Dams are built to obtain this energy. The water required for producing hydro-electric energy is available free of cost.

Hydal power stations do not add pollution to atmosphere.

Wind Energy

Wind has kinetic energy in it. A windmill is a machine which has blades. These blades move by the energy of wind. In recent years, a wind mill is being used to produce electricity. A wind farm (consists of about 100 windmills) is used to generate electricity in greater amount.

Wind energy is available without any cost.

Wind energy does not cause any pollution.

Biogas

Biogas is a mixture of gases. These gases are formed by the decay of animal wastes and water. A biogas plant is used to produce this gas. Biogas can be used as a fuel in homes. We can use the remaining material as a fertilizer.

The plant for biogas is also called gobar gas plant.

Biogas is cheaper than any other fuel.

It produces less pollution as compared to coal and petroleum.

Solar Energy

The Sun is the ultimate source of energy on Earth. The energy coming from the Sun is called solar energy. Solar energy can be changed into electricity with the help of solar cells. Solar energy can be an effective renewable energy source in our country.

Solar energy comes on the Earth free of cost.

This energy is also pollution free.

There is a lot of solar energy coming on the Earth.

Tidal Energy

The winds when blow over the surface of the sea, cause tides in it. In some countries, these tides are used to make electricity.

Energy from sea tides is also free of cost.

This energy does not cause any type of pollution.

Our body uses energy all the time; even when we sleep, our body requires energy. Our body needs energy to grow, to move and to keep warm. Our body gets energy from food. The food has stored energy. Our body changes this energy to the kinds of energy it needs, like heat energy and kinetic energy.

Energy Transfer in an Environment

Green plants use sunlight to grow and make food. This solar energy is stored in the form of chemical energy of food. Animals and human beings eat the food prepared by the plants. The chemical energy of food transfers to their bodies. The bodies of animals and human beings change the chemical energy of food to the kinds of energy they need. Heat energy and kinetic energy then dissipate in atmosphere. Similarly, solar energy causes wind energy, sea tides energy and many other forms of energy. All these energies change their form and at the end dissipate in atmosphere.

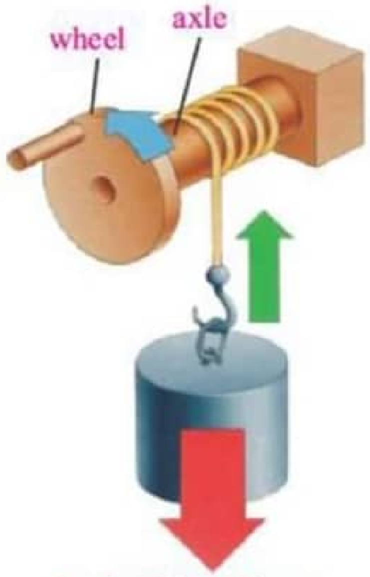
CHAPTER 9 FORCES AND MACHINES

- We know that a machine is anything that makes our work simpler and easier. A **simple machine** is a simple tool used to make our work easier. Lever, wheel and axle, pulley, inclined plane, wedge and screw are simple machines. All the complex machines like tractors, cars and fans are made of simple machines. We have learnt about lever, inclined plane and wedge in class five. Here we shall discuss wheel and axle, pulley and gears .

Wheel And Axle

- The most important invention of the human history is the "invention of the wheel".

- Wheels can move heavy objects easily. Wheels are used in a simple machine called wheel and axle.
- A **wheel and axle** consists of a large wheel fixed to a smaller wheel called the axle. When the wheel turns, the axle also turns.
- A wheel has bigger diameter than that of the axle.
- We use wheel and axle in two ways.
  To lift a heavy load ,we apply force on the wheel to turn the axle.
  To increase the speed, we apply force on the axle to turn the wheel.



A wheel has bigger diameter than that of the axle.

- A screwdriver is an example of wheel and axle. The broad part of the screwdriver works as a wheel. The narrow part of it acts as the axle.
- A small force on wheel provides a bigger force at the axle to push the screw into the wood
- . Also The steering wheel of motor vehicles is also an example of wheel and axle.
- A small force on steering wheel provides a big force to the axle that easily turns the wheels of the vehicle.

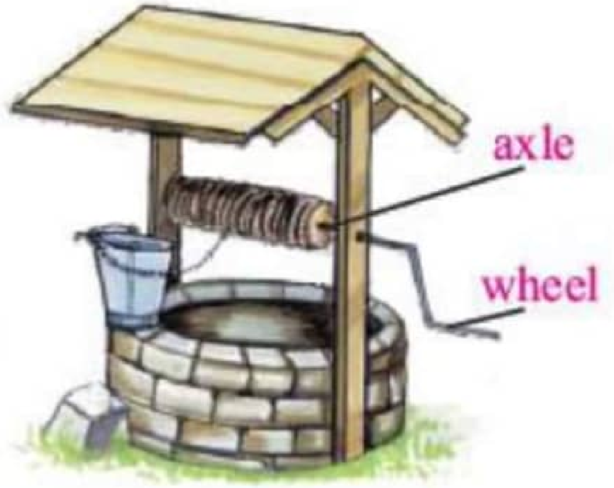
A screwdriver

Steering wheel

A mincing machine, a tap handle, a hand drill and crank on a well are examples of wheel and axle. Buses, cars and bicycles also contain wheels and axles.

A tap handle is a wheel.

The wheel and axle in this tricycle means it can roll smoothly along the ground.



Pulley

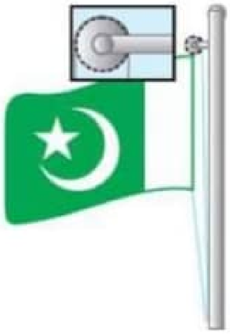
- Instead of axle, the wheel could also rotate a rope or cord. This variation of the wheel and axle is the pulley.
- A **pulley** is the wheel with a groove in its edge through which a cord is passed.
- The pulley turns around an axle. We can use pulleys to raise and lower objects.

A pulley

- A pulley changes the direction of force and makes our work easier.
- Pulley is used to lift construction material to upper stories on a construction site.
- Motor mechanics and engineers use pulleys to lift and place heavy engines in the cars.
- The pulley on a flag-pole changes the direction of applied force. We pull down one end of the rope that

passes over the pulley, the flag attached to the other end goes up.

- A crane uses a pulley system in which fixed and moveable pulleys are used to lift very heavy loads.



Types of Pulley

- There are two kinds of pulleys, i.e. fixed pulley and moveable pulley.

Fixed Pulley

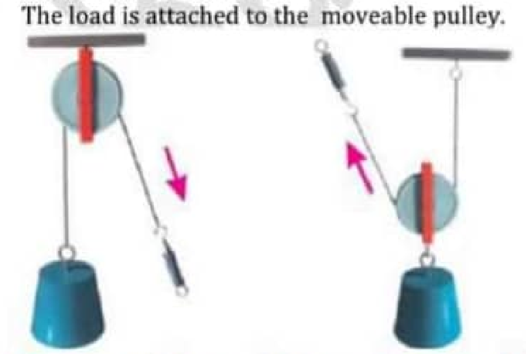
- The axle of this pulley is fixed with some support.
- The load is tied on one end of the rope which is passing over the pulley.
- The force is applied on the other end of the rope to lift the load.
- A fixed pulley is used to change the direction of applied force.

Moveable Pulley

- This kind of pulley has a hook to tie the load. The moveable pulley moves together with the load.
- In this kind, the rope is attached to some support while pulley moves.
- A moveable pulley does not change the direction of a force.
- The applied force and the load move in the same direction

Pulley System

- To make our work more easier, we can use pulley system.
- It consists of a fixed pulley and a moveable pulley. It is also called "block and tackle".
- The load is attached to the moveable pulley.



Fixed pulley Moveable pulley

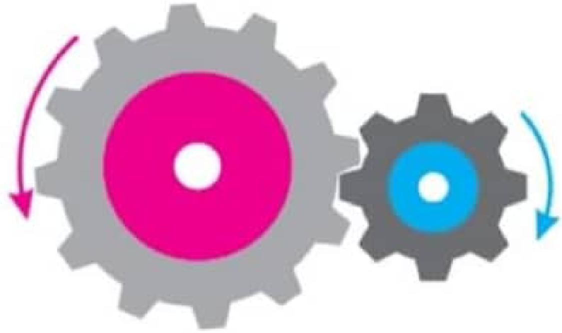
- Some times two pulleys work in such a way that they are connected with a belt.
- One pulley moves and causes the other pulley to move. For example in a water pump, a small pulley is attached to a motor.
- When motor runs the small pulley moves and causes the large pulley to move.

Gears

- A gear is also a modification of the wheel and axle.
- Gear wheel has teeth around it.
- The teeth of one gear usually fit into the teeth of another gear.
- Gears are used to transfer the force from one wheel to another. They can also increase or reduce the speed.

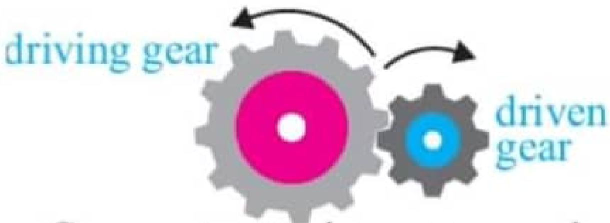
The Gear Train

- Gears work in teams. When two or more gears work together, it is called a **gear train** or gear system.
- One gear is called driving gear to which force is applied.
- The other gear is called driven gear which turns due to the movement of the first gear.



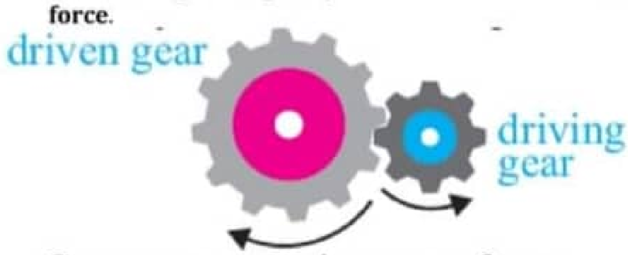
Gear train

- We can use a gear system in two ways.
- When the driving wheel is larger and the driven wheel is smaller, the gear system is
- used **to increase the speed.**



Gear system to increase speed

- When the driving wheel is smaller and the driven wheel is larger, the gear system is used **to increase the force.**



Gear system to increase force

Uses of Gears In Everyday

- Gears usually make part of a more complicated machine. They transfer energy from one wheel to the other to change the direction of force.

- A hand-drill consists of two mutually perpendicular gears. When its larger gear is rotated in a vertical plane, the smaller gear linked with it rotates very fast in the horizontal plane. A hand-drill is used to make holes in wood.
- Your bicycle moves with the help of gears. Two gears are linked with each other by a chain. The chain makes it possible for the small gear to move in the same direction as that of the big gear. The front gear is a large wheel with teeth in which pedal is fitted. The rear gear is a small toothed wheel which is present in the rear wheel of the bicycle. When you pedal the bicycle, you turn the big gear. The big gear turns the chain, which turns the rear small gear. When this small gear turns, the bicycle moves forward. In a racing bicycle, more than two wheels work in the gear system.

A hand-drill

- Have you ever seen a racing-bicycle? When a racer wants to increase the speed of a bicycle, he/she changes the gears or pulleys in such a way that the pedal gear is a larger wheel and the rear gear is the smallest wheel.
- A wind-up clock consists of many gears. The minute wheel is a smaller gear with a few teeth, while the hour wheel is a bigger gear with many teeth. The minute wheel rotates the minute hand and hour wheel rotates the hour hand.

  - Gears are also used in motor vehicles, factory machines and many other instruments.

CLASS 7TH SCIENCE

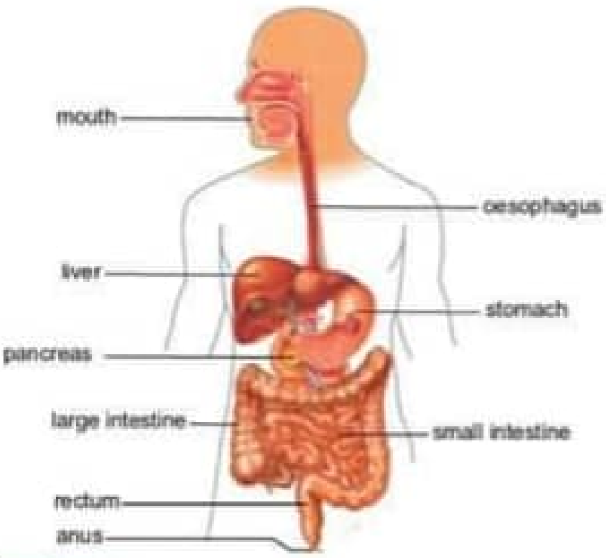
CHAPTER 1 HUMAN ORGAN SYSTEMS

Digestive System

- Our body needs energy and food to move, grow and to stay alive.
- Our body cells cannot use the food in the form it is eaten by us. Our body changes it into simpler form.
- The process of changing the food into simpler form is called **digestion**.
- The parts of body that take part in the process of digestion form the **digestive system**.
- Eating well is one of the most important things we can do to keep our body healthy. Different foods are the sources of nutrients. Nutrients are the useful parts of our food. Carbohydrates, proteins, fats, vitamins, minerals, etc. are the nutrients.
- Our digestive system breaks down nutrients into simple molecules. These simpler molecules can pass through the wall of digestive tube to enter the blood. The blood carries them to every cell to produce energy, or to become part of our body.

Mouth

- The process of digestion begins from our mouth.
- Our teeth break the food into small pieces by cutting and grinding.
- The tongue mixes food with **saliva** which is secreted by salivary glands.
- Saliva starts the digestion of carbohydrates (starch and sugar). After some time, the food in the mouth becomes soft and moist.
- The tongue pushes this food to the back of our mouth.



Oesophagus

- The chewed food is then pushed from the mouth into the oesophagus.
- The oesophagus is a large tube that carries food from the mouth to the stomach.
- The oesophagus uses wave-like muscular movements to push the food to the stomach. These wave-like movements are called peristaltic movements and process is called **peristalsis**.

Stomach

- Our stomach is a large J-shaped muscular bag.
- It mixes the food with digestive juice.
- The digestive juice begins the digestion of proteins (meat, egg, milk, pulses, etc.).
- The food spends about four hours in the stomach.
- The digestive juice in the stomach also contains an acid. The acid kills the germs present in our food. It also helps in the digestion of proteins.

Small Intestine

- As food leaves our stomach, it is passed on to the small intestine which is a long, thin tube coiled inside our abdomen.
- Final digestion of carbohydrates, fats and proteins occurs in the small intestine.
- Three organs help in the digestion of food here. These are the liver, pancreas and wall of the small intestine.
- The liver provides bile salts to make fats easier to absorb. The pancreas and intestinal walls secrete juices to digest the remaining food.
- The absorption of the digested food also occurs in the last part of the small intestine.
- The inner surface of small intestine has many finger-like structures called **villi**.
- The digested food passes into the blood through the walls of the villi.
- The blood carries food particles to all parts of the body.

Large Intestine

- The undigested part of the food passes into the large intestine.
- Here the undigested food has a large amount of water.
- The main job of large intestine is to absorb extra water.
- The undigested food becomes solid and is called faeces.
- The faeces is stored in the last part of the large intestine called the rectum.
- We pass the faeces out of our body through the anus.

Supporters of the Digestive System

- The liver, pancreas and gallbladder are not part of the digestive tube, but they are the supporters of our digestive system.
- **Liver**: The liver produces bile to digest fat. It also breaks down harmful substances in the blood.
- **Gallbladder**: The liver stores its bile in the gallbladder which releases it into the small intestine.
- **Pancreas**: The pancreas makes juice to digest remaining carbohydrates, proteins and fats.

Disorders of Digestive System

- Lemonade contains sugar and salt.
- Both sugar and salt help to absorb water in the body. So, use of lemonade is good during diarrhoea.
- Some common digestive system disorders are diarrhoea, heartburn, constipation, ulcer, gas-trouble, etc.

Diarrhoea

- Diarrhoea is passing semi-liquid faeces.
- It may be caused by an infection, eating contaminated food, a reaction to some medicine or just anxiety or excitement.
- Some of the most common symptoms of diarrhoea are: abdominal pain, cramping, bloating, nausea, loose motions, fever and bloody stools.
- Diarrhoea can be fatal in case of severe dehydration. Therefore, drink plenty of liquids, otherwise dehydration may take place. Doctors prescribe antibiotics to treat diarrhoea.
- We can prevent diarrhoea by following the tips given below.
  - Always wash your hands with soap after using the toilet.
  - Wash all fruits and vegetables before cooking or eating.
  - Don't eat uncooked meat and eggs.

Constipation

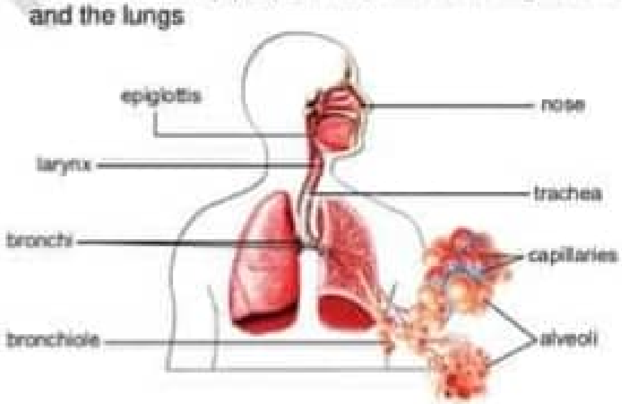
- Constipation is the painful or difficult passing of faeces.
- During the period of constipation some persons may pass faeces three or less than three times a week.
- It is a common digestive disorder in Pakistan.
- Constipation is caused by taking food low in fibre, lack of physical activity, not drinking enough water, delay in going to the washroom, etc.
- We can avoid constipation by:
  - Adopting a proper lifestyle.
  - Taking regular exercise.
  - Eating lots of fibre food (fruit, vegetables and cereals).
  - Drinking plenty of water (at least 8 glasses everyday).
  - Going to the washroom when we have the urge.
- Dietary fibre holds water in it and softens the faeces in the large intestine, so that it can pass out of the body easily.
- We can keep our digestive system healthy by eating food with plenty of fibre. Dietary fibre is found in cereals (wheat, corn, barley, oat, etc.), fruits (pears, guavas, grapes, oranges, apples, etc.) and vegetables (spinach, mustard, cucumber, etc.).

Respiratory System

- All living things need energy to move and grow.
- They get energy by breaking down food substances.
- We need oxygen to break down the food in every cell of our body.
- Our lungs take oxygen from the air during respiration (breathing).
- **Breathing** is the process that moves air in and out of the lungs.
- **Respiration** is the process by which living organisms use oxygen of air and food to produce energy.
- Carbon dioxide is also produced during this process.
- The parts of body used in the process of breathing form the **respiratory system**.

Parts of Respiratory System

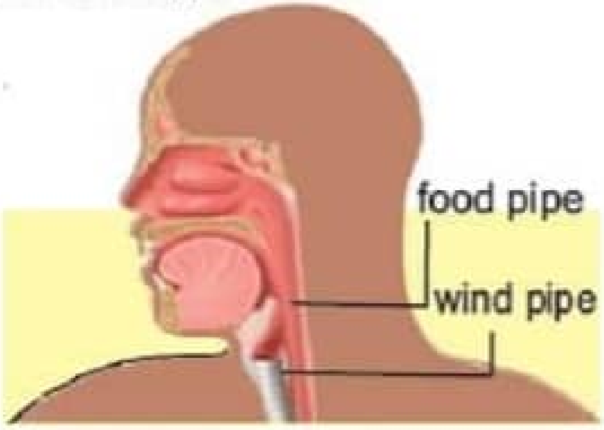
- Our respiratory system consists of the nose and throat, the wind pipe (trachea), the breathing muscles and the lungs



Nose and Throat

- The air enters through our nose or mouth.
- Our nose has hair and mucous to clean, moisten and warm the air.
- Mucous is a sticky liquid.
- Dust particles and germs present in the air stick to the mucous.
- The air enters the throat and passes through the larynx.
- Our vocal cords are present in the larynx to produce sound.
- Our throat contains two pipes — one for the food and the other for breathing.
- It is the epiglottis which allows things to go down the right way.

- When we eat or drink something, the epiglottis covers the windpipe.

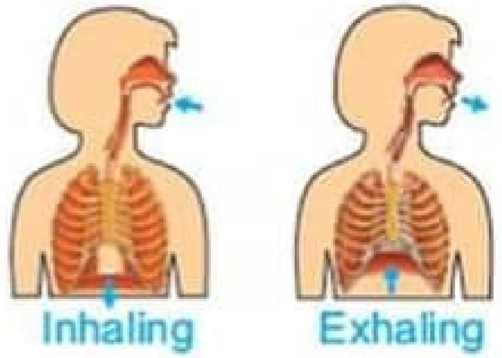


Trachea (Windpipe)

- Air passes from the larynx into the trachea or windpipe.
- Our windpipe is made of C-shaped rings of cartilage.
- These rings keep our windpipe open.
- Mucous and tiny hair in the trachea also filter the air.

Bronchi and Lungs

- The trachea divides into two branches called bronchi (singular bronchus).
- Bronchi carry air into the lungs.
- Our lungs are the most important organs of the respiratory system.
- In each lung the bronchus divides into smaller tubes called **bronchioles**.
- At the end of each bronchiole, tiny air sacs called **alveoli** are present.
- Alveoli are surrounded by blood capillaries.
- When we breathe in, the air enters the lungs and reaches the alveoli.
- Oxygen of the air passes through the walls of alveoli into the capillaries.
- The red blood cells carry this oxygen to every cell of our body.
- Cells in our body use oxygen and food to produce energy and carbon dioxide. The blood brings carbon dioxide back to the lungs. Carbon dioxide leaves our body when we breathe out.
- Our lungs have no muscles.
- Two types of muscles work during the breathing process ; the intercostal muscles of ribs, and the dome-shaped diaphragm. The process of breathing is completed in two steps:
- **Inhaling**: When the intercostal muscles pull our ribs outward and the diaphragm contracts, the air enters the lungs. It is called inhaling.
- **Exhaling**: When the intercostal muscles and diaphragm muscles relax, the air moves out of the lungs. It is called exhaling.



Comparing Breathing and Burning

- Breathing and burning processes can be compared.
  - During both processes energy is released from a fuel.
  - Both processes use oxygen and release carbon dioxide.
- The main difference between the two processes is the rate at which they release energy. During breathing, release of energy is very slow than burning and its rate can be controlled.

Common Diseases of Respiratory System

- Some common disorders of respiratory system are; common cold, influenza, pneumonia, tuberculosis and lung cancer.

Common Cold

- The common cold is a common disorder of respiratory system.
- The virus of common cold can spread from person to person by coughing, sneezing or touching things of a common cold patient.
- Symptoms of common cold are sore throat, cough, running nose, congestion, sneezing, headache, etc.
- We may have fever during the common cold.
- There is no proper medicine for the common cold.

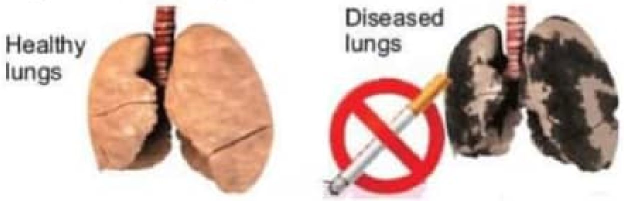
Pneumonia

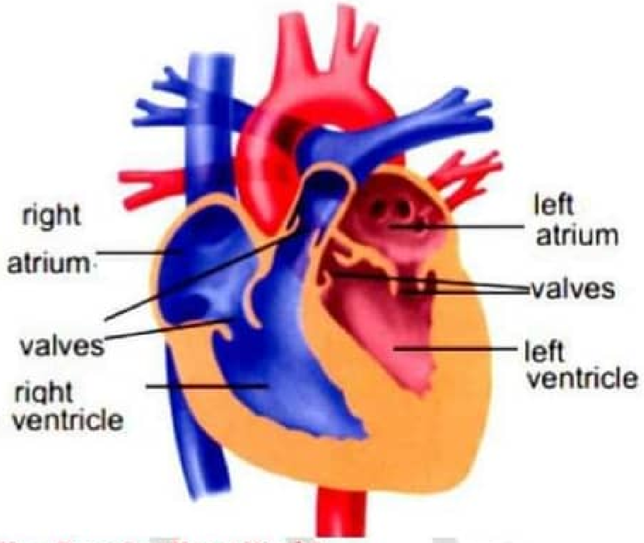
- Pneumonia is an infection that affects the lungs.
- The lungs are made of small sacs called alveoli, which are filled with air.
- When a person has pneumonia, the alveoli are filled with pus, which makes breathing painful. Pneumonia is the main cause of death in children worldwide.
- Common symptoms of pneumonia are cough, fever, nasal congestion, rapid breathing with wheezing sound, chest pain, loss of appetite, etc.
- Visit your doctor as soon as possible to treat pneumonia. Your doctor may prescribe an antibiotic medicine.
- Vaccines can also be used to prevent pneumonia.

Healthy Lungs

1. Fruit and vegetables contain vitamins. Vitamins keep our lungs healthy.
2. Exercises like running, walking, swimming, jumping, cycling, etc. are good for our lungs.

3. Avoid smoking. Smoking is the main cause of lung cancer.
4. Leafy green vegetables contain such chemicals that are good for our lungs.





CHAPTER 2 TRANSPORT IN HUMAN AND PLANTS

- The supply of food, water, oxygen, etc. and removal of wastes from our body is called **transportation.**

Human Blood Circulatory System.

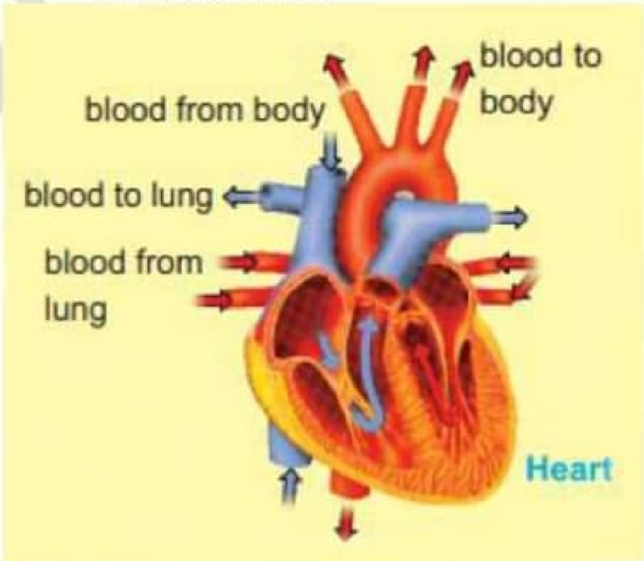
- Our circulatory system comprises the heart, blood vessels and blood.
- Our heart is a pumping organ. It pumps the blood in blood vessels.

The Heart

- Our heart is a muscular organ about the size of our fist.
- The heart is found in our chest.
- It pumps oxygen-poor blood (deoxygenated blood) to the lungs and oxygen-rich blood (oxygenated blood) to the body.
- There are four chambers in our heart; two upper chambers called **atria** (singular atrium) and two lower chambers called **ventricles** .
- The ventricles of our heart are larger than the atria.
- Both atria contract at the same time, and so the ventricles.
- The blood passes from the atria into the ventricles.
- There is a valve between each atrium and ventricle on the both sides of the heart. These valves keep the blood flowing in one direction.
- Deoxygenated blood from the body enters the right atrium and oxygenated blood from the lungs enters the left atrium of our heart.
- The right ventricle pushes the blood to the lungs and the left ventricle pushes the blood to the body.

How Does Our Heart Work?

- Human heart acts as a double pump.
- Blood from lungs and other body parts enters the atria.
- The two atria contract at the same time and push the blood to ventricles. It is one pump.
- Now both ventricles contract at the same time and pump the blood to lungs and other body parts. It is the second pump.
- Our heart beats about 70 times a minute.
- We can feel our heart beat (pulse) while placing our fingers below the base of the thumb on the underside of our wrist.



Blood Vessels

- The blood travels throughout the body through blood vessels.
- The three types of blood vessels are arteries, capillaries and veins.

Arteries

- Arteries are the blood vessels that carry blood away from the heart.
- Arteries have thick and flexible walls.

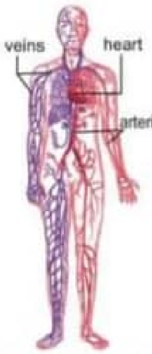
- Most of the arteries carry oxygenated blood, but pulmonary arteries carry deoxygenated blood to the lungs.
- Arteries divide many times to smaller tubes, called **capillaries.**

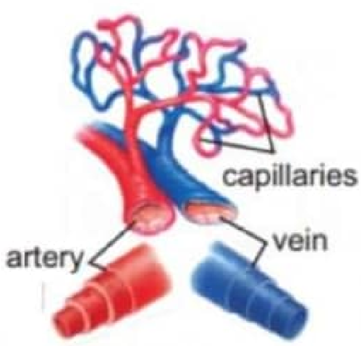
Capillaries

- Capillaries are the smallest blood vessels in the body.
- They are so small that red blood cells flow through them one cell at a time.
- Food and oxygen from the blood of capillaries diffuse into the cells.
- Waste materials and carbon dioxide from the cells diffuse into the blood of capillaries.
- Capillaries again join to form the larger blood vessels called **veins.**

Veins

- Veins are the blood vessels that bring blood back to the heart.
- Most of the veins bring deoxygenated blood back to the heart, but **pulmonary veins** bring oxygenated blood from the lungs to the heart .





Heart Attack (Myocardial Infarction

- The heart is made of muscle cells. These cells, just like other cells in the body, must receive oxygen and food through circulatory system.
- The blood vessels which supply oxygen and food to the heart are called **coronary arteries.**
- A hard substance called plaque can build up in the walls of coronary arteries. This plaque is made of fat and other cells.
- The coronary arteries may become narrow due to plaque. Sometimes a blood clot forms on the plaque and blocks coronary arteries. Due to this, the blood cannot reach a part of the heart. This part of the heart begins to die due to lack of oxygen and food.
- The death of a part of heart is called a **heart attack** or myocardial infarction.
- If too much heart muscle dies, the heart is unable to pump the blood and the person could die.
- Heart attack symptoms may include: chest pain, shortness of breath, heavy sweating, etc. which is a medical emergency.

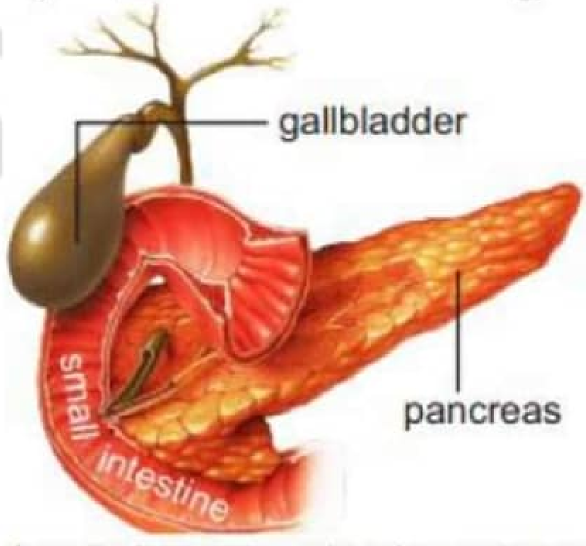
High Blood Pressure (Hypertension)

- High blood pressure is a disorder of circulatory system.
- Blood pressure is the amount of force exerted by blood against the walls of the arteries.
- If the blood pressure of a person remains above the normal value (120/80), the condition is called high blood pressure or **hypertension.**

A sphygmomano meter is used to measure the blood pressure.

Diabetes

- Diabetes is a disease in which a person has high blood sugar, because his/her body does not produce enough insulin.
- Insulin is the chemical that is produced in our pancreas .
- Insulin helps to decrease blood sugar. Without insulin a person develops diabetes.
- Loss of weight, frequent urination, excessive thirst and hunger, etc. are some of the symptoms of diabetes.
- If the patient does not control the level of blood sugar, he/she may be at the risk of loss of eyesight and hearing, heart attack, gum disease, kidney disorder, etc.
- A person can control his/her blood sugar level by taking medicines, eating proper diet and taking exercise.



Insulin is produced in the pancreas.

Asthma

- Asthma is an allergy that causes the airways of the lungs to swell and narrow.
- A person with asthma may wheeze (a whistling sound when he or she breathes), cough, and feel tightness in the chest.
- The things that can cause asthma are called **allergens.**
- Dust mites, pollen grains and some foods may cause asthma.
- Symptoms of an asthma attack may be cough , shortness of breath, wheezing, extreme difficulty in breathing, chest pain, sweating and increased pulse rate. Severe asthma attack may lead to death.

- It is not easy to cure asthma, but one can be normal and active even with asthma.
  - Try to avoid the allergens of asthma.
  - Use plenty of water, it will give you relief.
  - On advice of a doctor, use medicines or inhaler

Transplantation

- An organ **transplant** replaces a failing organ with a healthy organ.
- A doctor removes an organ from a healthy person and places it in the patient's body. The patient again lives a normal life after transplantation.
- Not all organs can be transplanted. Organs most often transplanted are:
  - **The kidney** because of diabetes or other kidney problems.
  - **The liver** because of serious liver disorders.
  - **The heart** because of heart failure.
  - **The pancreas** because of diabetes.
  - **The lung** because of serious respiratory disorders.
- People who have organ transplants must take medicines regularly the rest of their lives to stay healthy.
- Sometimes artificial organs are also used to restore a function in the body of a person.
- An **artificial organ** is a man-made device that replaces a missing natural organ.
- Artificial legs, arms, bones, arteries, eyes, teeth and ears are common to transplant now-a-days.
- The scientists who design and build artificial body parts are called **biomedical engineers**.

Transportation in Plants

- Plants do not have a circulatory system like humans and animals, but they too need to move water and food from one part to the other.
- Plants transport water and minerals from roots to leaves through xylem vessels. Phloem transports prepared food from leaves to all other parts.

Absorption of Water in Plants Through Roots

- The water enters the plant body through its roots.
- There are thousands of tiny root hairs on each root.
- The soil surrounding the roots has higher amount of water and minerals than inside the root cells.
- Water and dissolved minerals from the soil absorb into the root hairs by diffusion.
- Diffusion is the movement of a substance from where it is in large amount to where it is in small amount.
- As water in roots increases, a pressure is produced in the root cells to push water and minerals up in the plant. But this pressure of roots can only lift water up to a certain height.

Transpiration

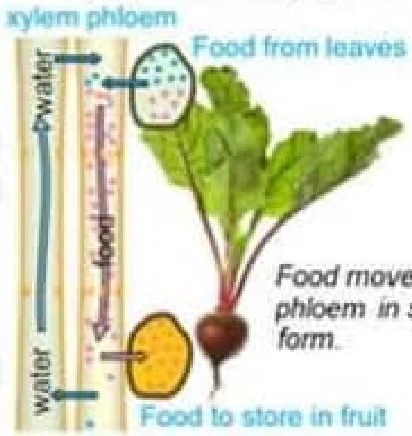
- In tall trees, water is pulled up through the xylem when it is evaporated from the leaves.
- Once in the xylem pipes, water forms unbroken columns from the roots, through stem and into the leaves.
- The loss of water by evaporation from plants is **called transpiration**.
- As water transpires, more water is drawn from the xylem. This movement of water exerts a pull on the water within the xylem.
- As water moves out of the leaves, more water moves up from the stem.
- Roots absorb more water from the surrounding soil to maintain the water column in stem and leaves.

Translocation

- Plants prepare food in their leaves.
- The prepared food is carried by phloem to all parts of a plant. The movement of prepared food from leaves to those parts of plant body where it is needed is called translocation

Pressure Flow Hypothesis

- We can explain the movement of solid food through the phloem by "pressure flow hypothesis".
- According to this hypothesis water from nearby xylem enters the phloem and mixes with the food forming a solution. This solution flows under pressure through the phloem.
- The pressure is created by the difference in amounts of water in phloem and nearby xylem.



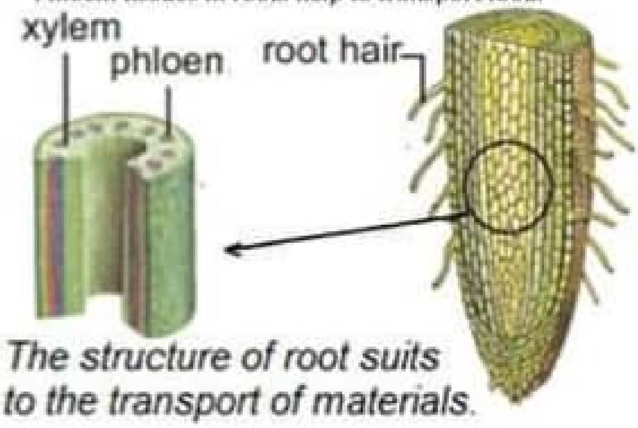
Food moves through phloem in solution form.

Structures of Plant Parts and Transportation

- Nature has made the plant parts in such a way that their structures permit the movement of materials.

Structure of Roots

- From the moment a seed grows, its root starts to search water and minerals in the soil.
- Roots have branches that play an important role in absorption of water.
- The root hair on the roots absorb water and minerals from the soil.
- Roots have xylem tissues to move water and minerals from the soil up through the stems, to the leaves.
- Phloem tissues in roots help to transport food.



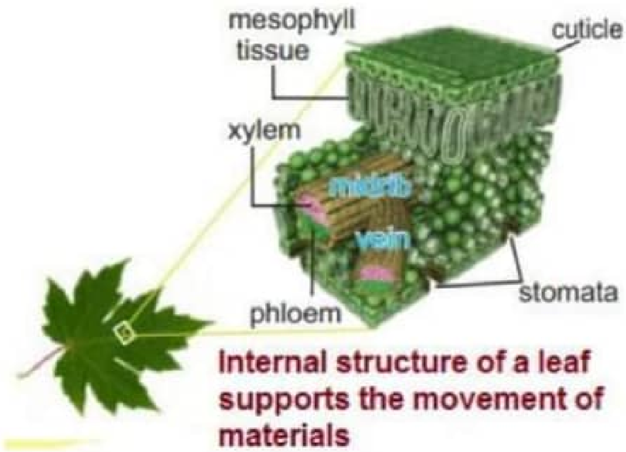
The structure of root suits to the transport of materials.

Structure of Stem

- Many plants such as mustard (sarsoon) have a waxy layer cuticle around the stem to reduce water loss.
- Bark also reduces water loss in plants.
- Phloem tissues in the stem transport food made in leaves.
- Xylem tissues carry water from roots to the leaves.

Structure of a Leaf

- Leaves are the food factories of plants.
- Upper layer of a leaf has a waxy layer cuticle to reduce water loss.
- Lower layer of a leaf has stomata.
- Exchange of gases and transpiration take place through stomata.
- Midrib and veins of a leaf have xylem and phloem tissues.
- These tissues transport water and food throughout the leaf



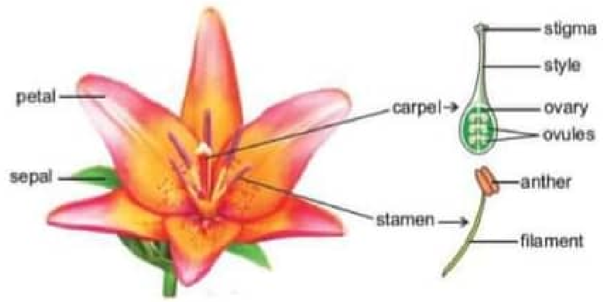
Internal structure of a leaf supports the movement of materials

CHAPTER 3 REPRODUCTION IN PLANTS

- A flower's colourful petals attract insects that pollinate the flower. Pollen grains stick to their bodies. Thus, they carry the pollen grains to part of the flower that makes seeds.
- All living things reproduce.
- **Reproduction** is the process by which organisms produce more organisms like themselves. It is a basic characteristic of living things.
- Flowering plants mostly reproduce through flowers.
- One major process in the reproduction of flowering plants is pollination.
- Pollination helps to produce new seeds that grow into new plants.

Pollination

- The transfer of pollen grains from the anther of a flower to the stigma of the carpel is called **pollination**.
- With the help of this process, the male sex cell (sperm) reaches the female sex cell (egg).
- Sex cells are also called gametes.
- Wind, insects, animals and water are the agents for pollination in different plants.

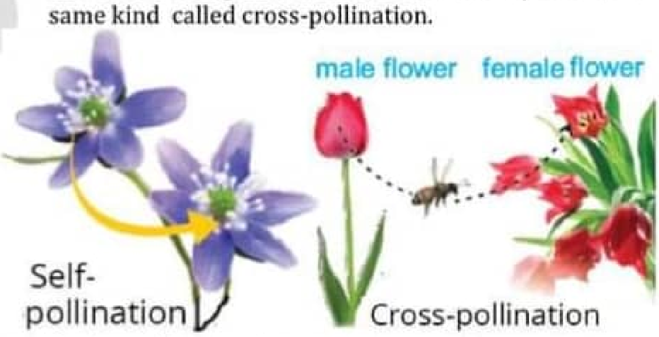


Parts of a Flower

- Most flowers have four main parts, i.e. sepals, petals, stamens and carpels. Green **sepals** protect the flower from the Sun and rain in bud form.
- The coloured **petals** attract insects and other animals for the pollination of the flower.
- **Stamens** are the male parts of a flower. Each stamen has a filament and an anther.
- Pollen grains are produced in anthers.
- **Carpels** are the female parts of a flower.
- Each carpel has a sticky stigma, a style and an ovary.
- Ovules are present in the ovary.

Kinds of Pollination

- There are two kinds of pollination, i.e. selfpollination and cross-pollination.
- The transfer of pollen grains from the anther to the stigma of the same flower or another flower on the same plant is called **self-pollination** (Fig.3.2).
- Pea, tomato, rice plants, etc. are self-pollinated.
- The transfer of pollen grains from the anther of a flower to the stigma of a flower on another plant of the same kind called cross-pollination.



- Poplar, willow, apple, papaya trees, etc. are cross pollinated plants.
- For cross-pollination, the plants must grow flowers at the same time. Crosspollination usually happens in plants near each other.
- Cross- pollination produces stronger plants as compared to the self-pollination.
- Some flowers have special features that favour crosspollination, e.g. coloured petals, long and sticky stigmas, nectar and fragrance.

Agents of Pollination (Pollinators)

- The agents that carry pollen grains from the anthers of flowers to the stigmas are called **pollinators**.
- Wind, water, insects, birds and bats, etc. are a few pollinators.

Pollination by Wind

- The wind picks up pollen grains from one flower and blows it onto another .
- Wind-pollinated plants have long stamens and carpels.
- Most grasses depend upon wind for their pollination.

Wind pollinated flowers produce a large number of pollen grains.

Pollination by Animals

- Insects and some other animals can also transfer pollen grains when they move from one flower to the other.
- Bright coloured petals, charming shapes, nectar guides and pleasant smell attract animals towards flowers.
- Pollen grains have rough and sticky surfaces, due to which they stick to animals' bodies.

Pollen grains stick to the bodies of bees as they visit flowers for food.

Pollination by Water

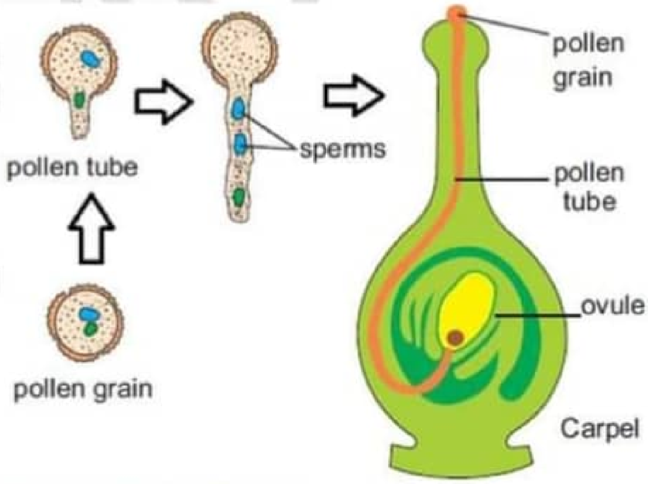
- Pollination by water is not common but a few plants release their pollen grains into the water.
- The pollen grains move slowly along the water currents and reach other aquatic plants.
- Hydrilla, Vallisneria, etc. are water-pollinated plants

Kinds of Reproduction

- Plants can reproduce in different ways.
- Non-flowering plants reproduce by producing spores.
- Flowering plants produce seeds.
- The type of reproduction in which a cell from only one parent develops into offspring is called **asexual reproduction.**
- Various methods of asexual reproduction are commonly found in plants.
- When two gametes one from each parent combine to form a zygote, the process is called **sexual reproduction**.
- Flowers are responsible in plants for sexual reproduction. The zygote formed in this process transforms into seed.
- **Zygote**: A male gamete (sperm) and a female gamete (egg) fuse to form a zygote. Later, the zygote develops into the seed and the seed grows into a new plant.

Fertilization in Plants

- The surface of the stigma in a flower is sticky and pollen grains stick to it. Here, a pollen tube grows out from each pollen grain.
- Two sperms are present in this pollen tube.
- The tube grows downward through the style and enters the ovary. Pollen tube finally enters an ovule and releases its sperms in it.
- One of the sperms combines with the egg to form zygote.
- The other sperm combines with another cell to make the store of food.



Changes after Fertilization

- After fertilization, several changes take place in the flower.
- The sepals, petals and stamens dry up and fall off.
- The fertilized egg inside the ovary develops into embryo. Ovules become seeds.
- The ovary grows large and develops into a fruit.
- The fruit protects the seed or seeds.

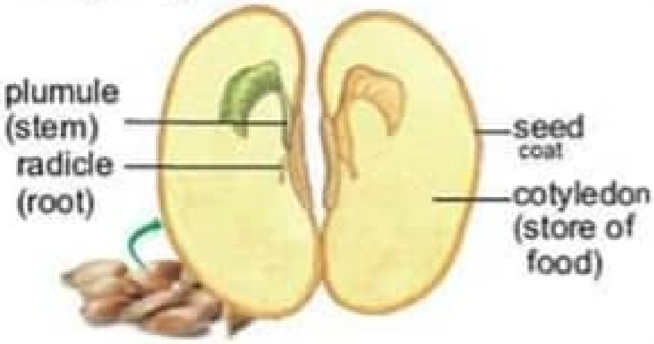
3.6: Formation of Seeds and Fruits

- Many plants grow and bear fruit to protect their seeds.
- A seed protects the embryo inside it.
- In addition, shapes of seeds and fruits help in their dispersal.

Seeds

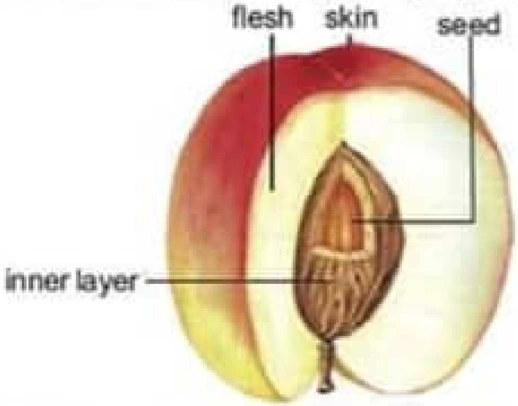
- After fertilization an ovule becomes a seed. The embryo and its store of food are covered by a tough seed coat.
- The most important part of a seed is its embryo.
- Embryo grows into a new plant. The embryo consists of the following parts.

- **Radicle:** This part of the embryo develops into the first root of the new plant.
- **Plumule:** This part of the embryo develops into the first shoot (stem) of the new plant.
- **Cotyledons** This part of the embryo supplies food to the growing young plant.



Fruit

- The ripened ovary is called a fruit.
- The ovary wall forms the fruit wall, called the **pericarp**.
- Inside the ovary, ovules develop into seeds. The matured fruit may contain single or many seeds.
- The pericarp has three layers in most fruits like peaches and mangoes.
- The outer layer is skin, the middle layer is fleshy and the inner layer is tough or hard.
- Some fruits have hard and dry pericarp, e.g. nuts.



Plants produce fruit to disperse their seed

CHAOPTER 4. ENVIRONMENT AND FEEDING RELATIONSHIPS

- Environment of an organism consists of all the living and non-living things around that organism.
- These living and non-living things affect the life of organism in one way or the other.
- All the organisms depend on each other and on non-living things in an environment.

Ecosystems

- A system formed by the interaction of living organisms and non-living things in an environment is called an ecosystem.
- An ecosystem may be large, like a desert, or small, like a decaying log.
- Deserts, seashores, rivers, mountains, oceans, grasslands and rain forests are also some of the ecosystems.

Parts of an Ecosystem

- All ecosystems are made of two parts:
- The living or biotic part
- The non-living or abiotic part
- All the plants, animals, fungi and microorganisms make the living or biotic part of their ecosystem.
- Organisms of the same kind living and reproducing in a particular area is called population.
- All the populations of different kinds of organisms living together in an area make a community
- Air, water, soil, sunlight and temperature make the non-living or abiotic part of an ecosystem.

Habitat

- The place where an animal or plant lives and reproduces is called its habitat.
- A habitat provides the things an organism needs, i.e. food, water, shelter, etc.
- Many populations of organisms live in each habitat.

Kinds of Habitats

- Organisms live in different kinds of habitats. An organism has special features to live in its habitat.

The Grassland Habitat

- Grassland is a grassy, windy, partly-dry area.
- These areas receive a medium amount of rain.
- The soil found here is very fertile.
- Grasses are the producers in a grassland habitat.
- Mostly grazing animals like the sheep, goats, cows, antelopes, buffaloes, and deer are a few examples that are found in a grassland.
- A few flesh-eaters like cheetahs, foxes, wolves and a few birds like owls, eagles, hawks, etc. are also found in this habitat.
- Many kinds of insects are also found in grasslands.

The Pond Habitat

- A pond is an aquatic habitat which is rich in life.
- Plants like algae, duckweed, water lily, etc. are found in water.
- The animals like fishes, pond skaters, wolf spiders, snails, frogs and microscopic organisms are also found in the pond habitat

The Desert Habitat

- Deserts are the driest land areas.
- They receive very little rainfall.
- Rainwater quickly drains away due to the sandy soil.
- Some plants and animals have adapted to the limited supply of water.
- Cacti, euphorbia, lizards, snakes, kangaroo rats, camels, etc. are found in a desert habitat.

The Rainforest Habitat

- Rainforests are always wet. They receive rain the whole year.

- A large number of plant types (herbs, shrubs and trees) is found here.
- Several varieties of butterflies, snakes, lizards, frogs, parrots, cockatoos, humming birds, cats and
- jaguars are also found in this habitat .

The Factors Causing Changes in a Habitat

- We know that light, temperature, air, soil and water are abiotic factors of the environment.
- Changes in these factors bring changes in the populations of a habitat. Some other natural factors and humans also cause changes in habitats.
- Sunlight
- Sunlight is the basic source of energy on the Earth.
- Plants use light energy to make their own food. All forms of life on the Earth depend directly or indirectly on green plants for food.
- They also need light for their survival.
- Light intensity affects the number of plants in a habitat.
- Decrease in number of plants may result in the decrease of animals' number in the habitat.
- Temperature
- Temperature can also bring change in the population of a habitat.
- Any extraordinary rise or fall in temperature may disturb the habitat.
- For example, warm water contains less oxygen.
- What happens to the aquatic animals in the water as it gets hotter?
- Water is essential for life. Where there is more water, more organisms are found there.
- Availability of water in a habitat can greatly influence its organisms.
- Migration is another factor that changes the size of populations of a habitat.
- When a few individuals come to an area, it increases the size of the population in that area.
- Organisms migrate in search of better living places.
- Natural disasters such as droughts, floods, earthquakes, etc. can bring changes in habitats.
- A drought is a period when there is no rain for a long time in an area.
- The ponds or streams may dry up during a drought.
- Most pond plants and animals die or move to other ponds.
- Some crops do not grow in the area affected by a drought.
- When an area gets a lot of rain for a long time, there may be a flood in that area.
- Many plants and animals die or move to other drier places during a flood.
- Sometimes lightning strikes a tree in a forest, causing forest fires. Plants and trees are burned and Destroyed.
- Some animals die, others may move to safer places. It takes many years for a forest to grow back. Earthquakes are sudden shocks of the Earth's surface.
- Earthquakes can change a habitat very quickly. On October 8, 2005, a massive earthquake damaged a widespread area across Pakistan.

How People Change Habitats

- Human activities also change habitats. When habitats change, some organisms die or leave the habitat.
- Farming is very important to human survival. People clear forests to get land for farming.
- People also cut down trees to get wood or paper. In this way they destroy the natural habitats of several plants and animals.
- Pollution is another agent that brings changes in habitats.
- Pollution harms the land, water or air. Pollution is harmful to people, animals and plants. It destroys many habitats.
- Land pollution affects the land, destroying life, the environment and its habitats.
- Air pollution affects the air we breathe in. Factories and motor vehicles add air pollution in the environment .
- Air pollution damages our health and our environment.

4.3.2: Adaptations of Organisms to Live in a Habitat

- Plants and animals live in different habitats. They develop special features that help them to live in their habitats. These special features are called adaptations.
- An adaptation is a change in the organism's body or behaviour that helps it to survive in its habitat. Organisms that are not well adapted to their habitats may not survive.

Aquatic Habitats

- Animals and plants living in aquatic habitats have such body parts that help them to live in water.
- Streamlined body shape is an important adaptation for animals to move easily through water.
- Webbed feet of ducks, seagulls and frogs work like oars to help move in water
- Floating plants like water hyacinth, duckweed and water lily have floating leaves and submerged roots. Their bodies contain air spaces. Their leaves have waxy covering to prevent water from collecting on them.

Land Habitats

- Animals and plants living in land habitats also have adaptations to adjust well in their surroundings.
- The arctic fox and polar bear have thick fur on their bodies. This thick fur keeps the body of these animals warm in freezing cold. Snowy owl has a thick coat of feathers.
- Plants and animals of deserts are adapted to live in scorching heat. Some desert plants have tough, thick surfaces and thin, spiny leaves to reduce water loss. Most animals, such as gecko(lizard) and jackrabbit conserve water by living underground during the day and coming out at night. Camel's feet and large stomach are the adaptations to live in deserts.

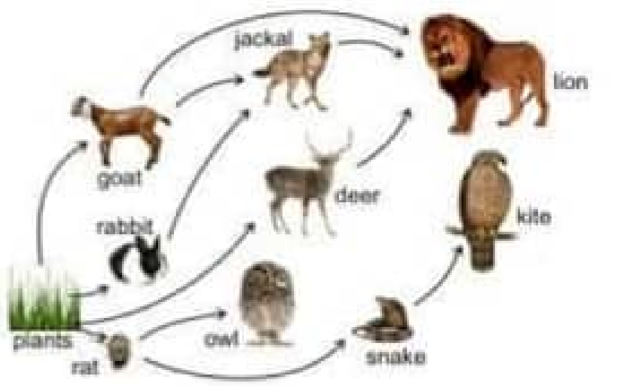
- Bird song, the roars of lions, howling of wolves, etc. are the adaptations of behaviour. Animals send and receive messages using sound .
- Plants, too, have many adaptations to help them survive. Trees in rainforests grow very tall to get the sunlight.

Biotic Components and Their Relation with Food Chains and Food Webs

- Every living thing needs energy. Energy in an ecosystem passes from one organism to another.
- The basic source of energy on Earth is sunlight. Plants use sunlight and make food. Thus, plants are the producers.
- Animals cannot make their own food .They eat plants or other animals that eat plants. Thus, animals are the consumers.
- A consumer may be a primary consumer (herbivore), a secondary consumer or a tertiary consumer. Organisms eat organisms and are in turn being eaten by others. This feeding relationship among organisms is called a food chain. Most food chains start with producers like:
- Grass → zebra → lion
- leaves → caterpillar → bird → hawk
- Green plants are producers so, they are the first in most food chains.
- Animals that feed on plants are the second in a food chain. They are called primary consumers. Animals that eat primary consumers are called secondary consumers.
- Secondary consumers may be eaten by tertiary

Food Web

- An organism can be a part of many food chains. Several food chains in an ecosystem overlap to form a network called food web.
- Example 1: A lion does not feed entirely on deer but it also hunts cows and goats. Similarly owl and hawk may also take different organisms as their food. So, most animals feed on one or more than one kind of animals. Therefore many food chains form a kind of network or a food web.
- Example 2: A snake does not feed on frog alone. It also eats birds, rats and even rabbits. Birds eat grains. They also eat insects, spiders and worms. If we arrange food chains in an ecosystem, it takes the form of a web.



CHAPTER 5 WATER

- Water is one of the most common compounds on Earth and its atmosphere.
- It covers more than 70% of the surface of the Earth.
- It exists in three physical states of matter, i.e. solid (ice), liquid (water), and gas (water vapours and steam).
- Water freezes at 0oC and boils at 100oC.
- The temperature at which water converts into ice is called its freezing point (F.P.) and the temperature at which water starts boiling is called its boiling point (B.P.).

Water H2O

- We know that everything is made of atoms. Atoms join together to form molecules.
- A water molecule has three atoms: two hydrogen (H) atoms and one oxygen (O) atom.\ A single drop of water contains billions of water molecules.
- 5.1: Water for life
- All living things need water to survive. Plants, fish, insects, birds and other animals all need water to grow.
- Green plants must have water to make food during photosynthesis.
- Some plants and animals live only in water. Aquatic animals use oxygen dissolved in water.
- Aquatic plants use carbon dioxide dissolved in water.
- Our body also needs water. Water makes up about two-third of our body. Water helps us in several ways.
- Water helps to digest our food. It helps to remove waste products from our body.
- Water keeps our body cool in hot weather by sweating which is mainly water.
- We might be able to live for a month without food, but we cannot survive without water for more than a week.

Facts about Water

- Water makes up 95% of our blood, 75% of our brain, and 85% of our lungs.
- Overall, our bodies are 60–70% of water.
- A tomato is about 95% water. An apple is about 85% water.
- Pure water has no colour, no taste and no smell.

Sources of Water

- Water is present not only on the surface of the Earth but also beneath its surface.

Surface Water

- About 97% of Earth's surface water is found in the oceans. It is salt water.
- Only 3% of water is fresh water which is present on the surface of the Earth, in the air (water vapours) and under the ground.

Ocean Water

- Ocean water is a mixture of dissolved gases and salts in pure water.
- The major dissolved gases in ocean water are nitrogen, oxygen and carbon dioxide.
- The major dissolved salts are sodium chloride (table salt), magnesium chloride, magnesium sulphate and calcium sulphate, etc.
- Sodium chloride is the most abundant salt in ocean water.
- Ocean water is unusable for drinking because of salts. Some countries like Saudi Arabia, Kuwait, etc. remove salts from the ocean water to make it drinkable.

Fresh Water

- Most of the fresh water is frozen. The frozen water is found in mountains in the form of glaciers.
- Snow accumulates year after year to form ice sheets. These ice sheets are called glaciers.
- Fresh water is also found in streams, rivers, lakes and ponds. At some places where ground is low, the water stays for part of the year and makes the ground very wet. Such places are called wetlands. Pugri, Kur and Kharki are a few wetlands in Sind Province.
- The water in wetlands moves down into the soil and becomes groundwater.

Water Beneath the Surface of Earth

- Recall what happens to rain when it falls! Rainwater can evaporate, run off the surface, or soak into the ground.
- The water that soaks into the ground is called groundwater. The top level of groundwater in an aquifer is the water table. The level of water table changes during the year. It rises when water is added by rain. It becomes lower when there is a drought. People dig wells to bring groundwater to the surface.
- At some places, the water table rises and reaches near the surface of the soil. This water may come out in the form of spring or geyser. Several natural springs are found in Nathia Gali (KP Pakistan).

Impurities of Water

- We need clean drinking water.
- Our water resources are becoming unfit due to the presence of impurties in water.
- Water may have germs. It may also have salts, dirt or other chemicals in it.
- The addition of harmful substances into the water is called water pollution.
- Harmful and unwanted substances in water are called pollutants.
- We can classify water pollutants into different groups.
- Bacteria, virus and other microorganisms are disease causing pollutants.
- Acids, salts, etc. are water soluble pollutants.
- These pollutants can increase the growth of algae in the water.
- The presence of algae can block the sunlight to reach other plants in the water.
- Plants cannot make their own food and die. As a result, fish and other aquatic animals also die.
- Oil, plastic and pesticides are also harmful to all plants and animals in the water.

Sources of Water Pollution

- The three major sources of water pollution are human wastes, industrial wastes and chemical run off.

Human Wastes

- People release sewage into drains which carry it to rivers. Sewage from houses contains fat, toilet wastes, food particles, detergents, harmful bacteria, etc. These human wastes not only cause diseases in human beings but also destroy aquatic life.

Industrial wastes

- Industries release a large number of toxic chemicals into rivers and canals.
- Smoke and toxic gases released from industries also cause the rain water to become acid rain.
- These chemicals can kill fish and other aquatic animals and plants.

Fertilizers

- Farmers use fertilizers and pesticides in their crops . The rainwater carries these chemicals to water resources and causes water pollution. This polluted water is not fit for aquatic plants and animals.
- The water which gives rich lather with soap is called soft water.
- The water we use in house is soft water. The water which does not give good lather with soap, but forms curds is called hard water. Sea water is hard water. Water becomes hard when chloride, sulphate or carbonate salts dissolve in it.

Cleaning of Water

- Water may have germs, dirt, salt and other things dissolved in it. All of these things must be removed before drinking the water. The process of removing impurities from water is called purification of water. We can use following methods to purify water.

By Filtration

- In laboratory, we can purify water by this method on small scale.

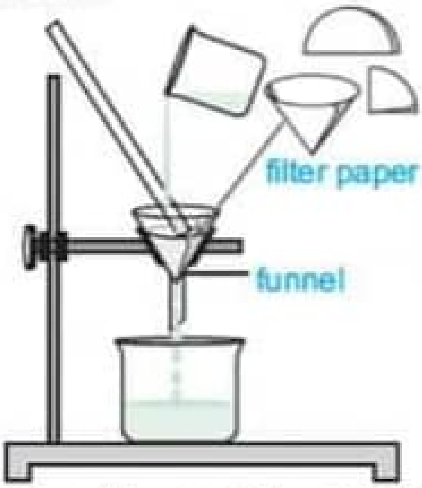
- Impure water is passed through a filter paper.
- Suspended particles and insoluble salts are left on the filter paper whereas clear water is obtained in the beaker. To remove dissolved substances present in the water, special membranes can be used.
- These membranes have microscopic pores to separate dissolved substances from the water.

By Boiling

- Boiling is the safest way to purify water. In villages, people can easily use this method to purify their drinking water.
- Bacteria, germs and other microorganisms present in water are killed by boiling water for 15 to 30 minutes. The water is cooled before drinking.

By Chlorination

- If boiling is not possible we can add liquid household bleach to the water.
- Bleach contains chlorine. For this purpose, place the water in a clean container.
- Add the amount of bleach or chlorine according to the table below:



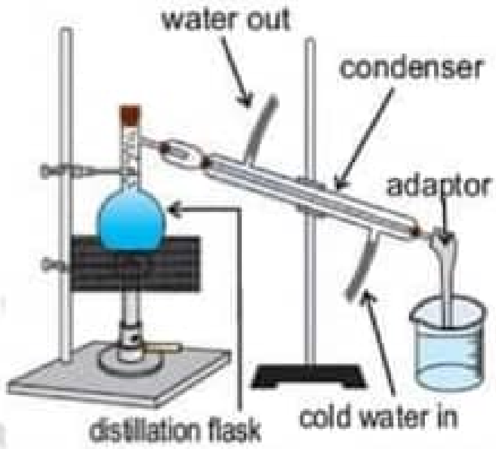
In laboratory, a filter paper is used to purify water.

Use of Potash Alum

- We can add potash alum to the water to purify it. Sand, clay and other suspended impurities of water will settle down. Water will be pure after decantation.
- Water coming out of a natural spring may contain sulphur. Presence of sulphur makes this water germicidal. People use water of such spring to treat skin diseases.
- Every year, a large number of children die because of water-related diseases such as diarrhoea.

Distillation

- We get clear tap water, but it is not pure. It may contain some salts and bacteria in it.
- We can use the process of distillation to separate impurities from water. In simple distillation , the water is heated to convert into steam. Then the steam is cooled down into distilled water
- Impure water is boiled in a closed container (flask). Water vapour from the surface of boiling water pass through a pipe into a vessel called a condenser.
- The condenser is a tube surrounded by a large tube through which cold water is passed to cool the water vapours.
- As the water vapours pass through the condenser, they lose heat and become liquid water. This distilled water is collected in a separate container (beaker).
- Solid impurities remain at the bottom of the flask.



We can obtain the purest form of water by the process of distillation.

Uses of Water

- People in Pakistan use water in homes, agriculture, as a source of energy (hydroelectricity) and in industries.

In Homes

- A large quantity of water is used in our homes.
- We use water in washing, cleaning, brushing the teeth, flushing the toilet, cooking and drinking.
- People use most of the water in their kitchens and bathrooms.

In Agriculture

- Plants need water to grow.
- Our farmers use 88% of our fresh water in fields to grow crops and

As a Source of Energy— Hydroelectricity

- The potential energy of water is used to move propellers of turbines.
- Turbines in turn run generators that produce electricity which is called hydroelectricity.
- There are five major and several small hydroelectric projects in Pakistan.

In Industries

- Industries use water in a number of ways.
- Beverage and food industries use water as a raw material.
- Factories use water to clean and wash metal surfaces.
- Heavy mechanical complexes, oil refineries and nuclear reactors use water for cooling purposes.

- People also use water for water sports such as swimming, fishing, sailing, etc. We can enjoy water sports in water parks.

How to conserve water?

- There is only a limited amount of fresh water that we can use. We can save water by acting upon following tips:
- Turn off the tap when you brush your teeth or take water in a tumbler.
- Wash fruits and vegetables in a bowl.
- Don't wash dishes under running water.
- Only use washing machine with a full load.
- If you have a lawn, water it early in the morning or late in the afternoon so the Sun would not evaporate the water. Check regularly the leaks in water pipes and get them repaired immediately.

- Paper mills, oil refineries, chemical industries, heavy mechanical complexes and nuclear power plants should conserve water by:
  - reducing water use.
  - recycling of water.
  - reusing water.

CHAPTER 6 STRUCTURE OF AN ATOM

Structure of an Atom

- Atoms are made of even smaller particles called electrons, protons and neutrons.
- The central part of the atom is called the nucleus.
- Protons and neutrons are present in the nucleus.
- Electrons revolve around the nucleus.
- An electron has negative charge. Its mass is extremely small.
- A proton has positive charge.
- The number of protons in an atom is equal to the number of electrons revolving around the nucleus. It has a mass 1837 times greater than that of electron.
- A neutron has no charge. This neutral particle is also found in the nucleus of an atom. The mass of
- a neutron is almost equal to the mass of a proton.

Why is atom neutral?

- Although electrons and protons in an atom have charges, but atom as a whole has no charge.
- In an atom, the number of protons is equal to the number of electrons. As a result, the total positive charge of protons balances the total negative charge of electrons. Because of it, the atom is neutral.

Atomic and Mass Numbers

Atomic Number (Z)

- The number of protons present in the nucleus of an atom is called the atomic number. It is represented by Z.
- The hydrogen atom has one proton in its nucleus; its atomic number is 1. Carbon atom has six protons in the nucleus; its atomic number is 6. An oxygen atom has 8 protons in the nucleus. What will be the atomic number of oxygen? Each element has its own atomic number. We can identify an element by its atomic number.

Mass Number (A)

- The sum of protons and neutrons in the nucleus of an atom is called its mass number. It is represented by A. The hydrogen atom has only one proton in its nucleus, its mass number is also
- Carbon has 6 protons and 6 neutrons. Its mass number is 12. We can use atomic numbers and mass numbers to find the number of neutrons in atoms.
- Mass number (A) = Number of protons (Z) + Number of neutrons (N)
- General symbolic representation of an element is thus given as:
- $^{A}_{Z}X$ Where X denotes any element.

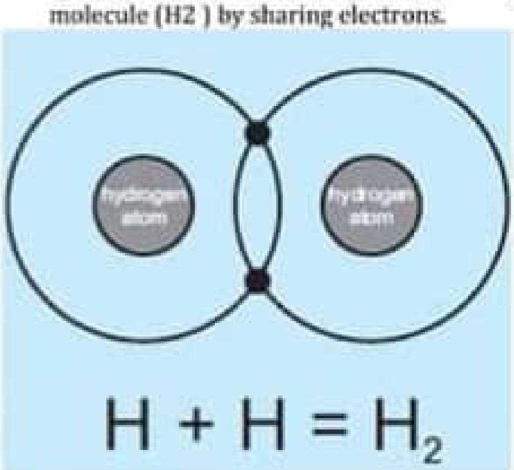
Distribution of Electrons in Shells

- We know that electrons revolve around the nucleus of an atom.
- The paths of movement of electrons around the nucleus are called shells.
- Electrons are distributed in different shells.
- Shells are also called as energy levels.
- These shells are labeled as K, L, M, N, O, P, Q, etc. K is the first shell.
- Number of electrons in a shell = $2n^2$ ('n' is the number of shell)

Shell number	Maximum number of electrons
Shell number 1 or K-shell	2n2 = 2(1)2= 2
Shell number 2 or L-shell	2n2 = 2(2)2 = 8
Shell number 3 or M-shell	2n2 = 2(3)2 = 18

Why do atoms combine?

- Atoms combine with other atoms but they stop reacting with other atoms (become stable) when their outermost shell is complete having 8 electrons, or they have only one shell (K-shell) with 2 electrons. For this purpose an atom can lose, gain or share its electrons with other atoms.
- Two hydrogen atoms combine to form a hydrogen molecule (H2) by sharing electrons.



Valency and Ions

Valency

- Valency is the capacity of an atom to combine with the other atom.
- Valency can also be defined as follows. "The number of electrons that an atom wants to lose, gain or share is called its valency."
- For example, sodium atom (Na) loses one electron. It's valency is '1'.
- Fluorine atom (F) gains one electron. Its valency is '1'.
- Hydrogen (H) shares one electron. Its valency is also '1'.
- Copper, magnesium, oxygen, etc. have valency number '2'.
- The valency of aluminium and nitrogen is '3'.
- The valency of carbon atom is '4'.

Ion

- An atom with positive or negative charge is called an ion.
- For example, sodium ion (Na+), chloride ion (Cl-), oxide ion O2-, copper ion (Cu2+), etc.
- When an atom releases its one or more electrons from the outermost shell, the number of protons more than that of electrons. It becomes a positive ion or cation.
- When an atom absorbs one or more electrons in its outermost shell, the number of electrons increases.
- It becomes a negative ion or anion.
- Positive ions and negative ions attract each other to form compounds.

Isotopes and their Uses

- All atoms of an element always have the same number of protons.
- However, the number of neutrons may be different in some of these atoms.
- It means some atoms of the same element may have different mass number than the others.
- The atoms of the same element having same atomic number but different mass numbers are called isotopes. Hydrogen (H) has three isotopes.
- An atom of hydrogen may have zero, one or two neutrons in its nucleus.
- Protium (^1_1H1) Deuterium(^2_1H) and Tritium(^3_1H) are three isotopes of hydrogen.
- Carbon (C) has three isotopes, i.e. $^{12}_6C$, $^{13}_6C$, $^{14}_6C$
- Isotopes are of great importance in the fields of medicine and agriculture.
- Carbon-14 is used to calculate the age of plants.
- Nitrogen-15 is used to study the effects of nitrogenous fertilizers in plants.
- Sodium-24 is used to study circulation of blood.
- Phosphorus-32 is used in treatment of blood cancer and bone diseases.
- Chromium-51 is used to study red blood cells in patients with blood deficiency.
- Iron-59 is used to study absorption of iron in human body.
- Cobalt-60 is used in cancer treatment.
- Iodine-131 is used to treat a disease called goiter.

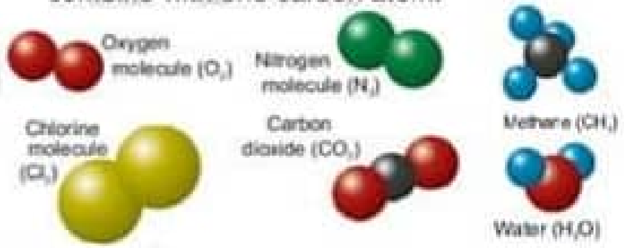
Molecules and Chemical Formulae

Molecule

- A molecule is the smallest particle of an element or a compound that can exist independently and shows all the properties of that element or compound.
- It may be a monoatomic molecule such as helium (He), neon (Ne), etc.
- Two or more atoms can also be present in a molecule.
- For example, water (H_2O), hydrogen gas (H_2), glucose ($C_6H_{12}O_6$), etc.

Chemical Formula

- Describing a molecule in the form of symbols and valencies is called the chemical formula.
- The chemical formula of a molecule shows kinds of elements in the molecule and number of atoms of each element
- For example, H_2 represents a molecule of hydrogen gas. It contains two hydrogen atoms.
- Similarly, CO_2 is the formula of carbon dioxide gas which shows that two atoms of oxygen combine with one carbon atom.



Writing a Chemical Formula

- The chemical formula of a molecule of an element is denoted by the symbol of that element with a subscript .The subscript tells the number of atoms present in the molecule.

- The chemical formula of a molecule of a compound is denoted by the symbols of all elements present in that molecule.
- A subscript is given, when two or more atoms of an elements are present.
- When no subscript is given, the number of atom is assumed as '1'.
- *Water molecule: (One oxygen atom combines with two hydrogen atoms.)*
- *Methane molecule :(One carbon atom combines with four hydrogen atoms.)*

Making Chemical Formula of Ionic Compounds

- When a positive ion (cation) attracts a negative ion (anion), an ionic compound is formed.
- Sodiam chloride (NaCl), magnesium chloride ($MgCl_2$) are examples of ionic compounds.
- To write the formula of an ionic compound, follow these steps:

  Step-1: Write the symbol of positive ion(cation) on the left and symbol of negative ion(anion) on the right.

  Step-2: Put the valency number of each ion with its charge on its top right side.
- Step-3: Interchange the valency numbers of both ions and write them on lower right side of each ion. Omit the +ve and -ve signs which cancel each other. Remember that number '1' is also omitted. This method of writing chemical formulae is called crisscross method.

Law of Constant Composition

- Composition refers to the type and number of atoms present in a substance.
- In the late1700, a French scientist Joseph Proust studied the chemical compounds and presented The Law of Constant Composition.
- The law states that the composition of a compound is always the same regardless of how the compound was made or obtained.
- Water can be obtained from many sources (river, well, sea, etc.), but its composition is always the same.
- There are 2 atoms of hydrogen and 1 atom of oxygen present in a molecule of water (H_2O).
- Carbon dioxide (CO_2) is produced in a number of ways, but its one molecule always consists of one carbon atom and two oxygen atoms.

CHAPTER 7 PHYSICAL AND CHEMICAL CHANGES AND PROCESS

- Changes in materials are going on around us all the time.
- Leaves change their colour; trees shed their leaves, milk changes to curd, and iron nails rust in moisture.
- Some changes around us are slow and some are fast.

Types of changes

- Most of the changes in materials are of two main types, i.e. physical changes and chemical changes.

Physical Changes

- A physical change is one in which only the physical properties of a substance change and its chemical composition remains the same.
- Size, shape, colour, etc. are the physical properties of a substance.
- Physical changes are temporary and can easily be reversed.
- Freezing of water, cutting fruit into pieces, switching on the bulb, dissolving of something into another, etc. are some examples of physical changes
- Ice melts or water freezes, it does not change the composition of water (H2O).
- Melting of ice or freezing of water are physical changes.

Chemical Changes

- *A chemical change is one in which a new substance is formed.*
- Chemical changes are permanent and are not easy to reverse.
- Burning of paper, rusting of iron, turning of milk into yogurt, cooking of food, etc. are some examples of chemical changes. Coal is carbon. When we burn coal, it changes into smoke, energy and ash. So, burning of coal is a chemical change because new substances are formed during this process.

Applications of Chemical Changes

- As a result of chemical changes new products are formed.
- We are living in the world of chemical changes.
- Chemical changes are taking place in our bodies, in our vehicles and in our environment.
- Sometimes chemical changes form harmful substance.

Use of Hydrocarbons as Fuels

- Burning of fuels is another example of a chemical change.
- Fuel that we use to run our vehicles or factories consists of substances known as hydrocarbons.
- A hydrocarbon is a compound consisting of only hydrogen and carbon atoms.
- These hydrocarbons are mostly obtained from crude oil (petroleum).
- When hydrocarbons burn in the presence of oxygen their chemical compositions change. As a result of burning of hydrocarbons, a lot of heat is produced.
- People use the heat for various purposes such as cooking, heating, movement, etc.

Use of Fertilizers in Agriculture

- Repeated cultivation of crops decreases the fertility of soil.
- Farmers use certain substances to increase the fertility of the soil.
- A substance which adds minerals to the soil is called a fertilizer.
- It may be a natural fertilizer or a chemical fertilizer.
- Chemical fertilizers are prepared in factories.

- Many chemical changes take place during their preparation.
- Most fertilizers supply nitrogen (N), phosphorus (P) and potassium (K) elements to the soil (known as NKP).
- Physical properties of fertilizers such as particle size and their hardness are very important.
- Small sized particles of a fertilizer dissolve easily in water.
- Hard particles are better than soft ones because they release nutrients gradually.
- liquid fertilizer is a clear solution. It contains the nutrients essential for plants.
- Liquid fertilizers are dustless and they reach to every plant easily

Harmful Effects of Improper Use of Fertilizers

- In case of excess spreading, some fertilizers are not absorbed by the plants.
- These fertilizers may reach into canals and rivers causing water pollution and encourage the growth of algae.
- During the manufacture of chemical fertilizers a lot of fossil fuel such as coal and natural gas is used, due to which our fossil fuel reserves are reducing quickly.
- Waste materials of plants and animals are called manure. Manure is rich in nutrients needed by the soil. Chemical changes in manure increase the production of crops.

How does Vegetable Oil Change into Fat?

- A chemical process called hydrogenation changes vegetable oil into solid fat (Banaspati ghee).
- When hydrogen is passed through vegetable oil in the presence of nickel, it converts into solid fat. This process is called hydrogenation.
- Vegetable oil is liquid while fat (ghee) is solid at room temperature.
- A large amount of heat is used to bring about this chemical change.
- Vegetable oil + Hydrogen → Banaspati ghee (fat)
- Margarine is the result of chemical changes. It is a mixture of hydrogenated vegetable oil and skimmed milk. In hydrogenation, hydrogen is passed through the vegetable oil.
- Some people use margarine in place of butter.

Plastics

- Plastics are also the result of chemical changes.
- A plastic is any material that can be moulded into any form.
- Plastics are very large molecules made from many smaller molecules called monomers.
- That is why plastics are also called polymers (long molecules made from smaller molecules).
- Monomers are obtained from crude oil.
- Polyethylene, polyvinyl chloride (PVC), etc. are some examples of plastics.
- By heating, plastics can be moulded into a number of shapes, in form of toys, cups, bottles, utensils, etc. Plastics do not decay and therefore are a cause of pollution.
- Recycling is the best way to deal with pollution caused by plastics..

Reversible and Irreversible Changes

- A change that can go forwards or backwards is called a reversible change. It is a temporary change.
- We can get the same thing again. Melting of ice into liquid water, switching on a tube light, increase of heartbeat during running, mixing of salt in water, wetting a dry cloth, etc. are reversible changes.
- A change that cannot go back is called a irreversible change. It is a permanent change.
- We cannot again get the thing in its original form.
- Turning of milk into yogurt, mixing of plaster of Paris with water, burning of paper and wood, rotting of egg or fruit, etc. are examples of irreversible changes.
- In a physical change, only shape, size or physical state of a material changes. In a chemical change, a material changes into a new material.

CHAPTER 8 TRANSMISSION OF HEAT

- The small particles that make up matter are constantly moving. They have kinetic energy.
- The kinetic energy of particles in matter is called **thermal energy**.
- When thermel energy is transferred, it is known as heat.
- The word thermal means 'heat'.
- **Heat** is the thermal energy that flows from an object. Heat flows from an object at higher temperature to an object at lower temperature. In this chapter, we shall learn about different modes of heat transfer.

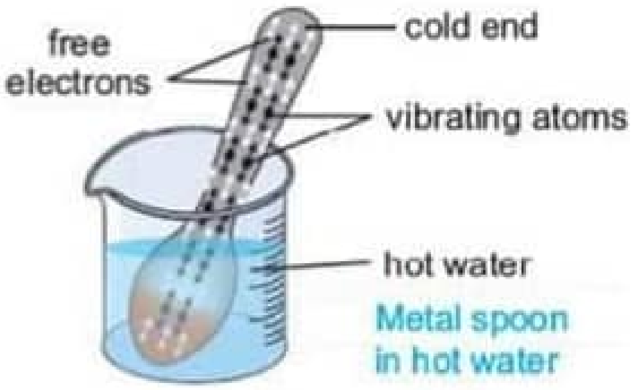
Transfer of Heat

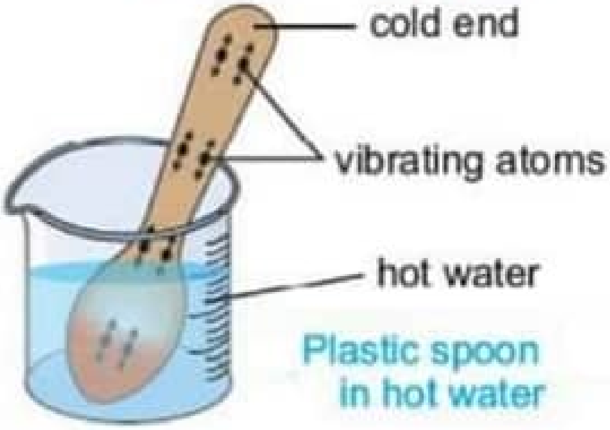
- The transfer of heat energy from one object to the other is called **transmission of heat**.
- Heat energy transfers in three ways, i.e. conduction, convection and radiation.

Conduction

- If one end of a metal spoon is heated with a flame, the other end will also get heated up after a while (Fig.8.1). The heat energy is transferred from one end of the spoon to the other without the actual movement of particles (atoms or molecules) of the spoon. Such a mode of transmission of heat is called **conduction**.
- The transfer of heat through matter without the actual movement of particles from their position is called conduction.
- Conduction occurs in solids, liquids and gases, but solids usually conduct heat better than liquids or gases.
- In solids, the particles are held very close to each other. They vibrate constantly.
- When we heat one part of a solid, the particles gain heat energy and start vibrating faster. During their vibration they bump into nearby particles and also cause them to vibrate fast. In this way, the particles

of hot part of a solid transfer heat to those in the colder parts.





Good and Bad Conductors

- Different materials conduct heat at different rates.
- Materials which allow heat to flow through them easily are called good conductors of heat.
- Solids such as metals are good conductors of heat.
- Materials which do not allow heat to flow through them easily are called bad conductors of heat or heat insulators.
- Solids such as wood, glass, plastic, styrofoam, etc. are bad conductors of heat.
- All liquids (except mercury which is a liquid metal) and gases are also bad conductors of heat.
- Good Conductors: silver , copper , aluminium , iron , mercury
- Insulators : air or any gas, cork, glass, plastic, wood

Why metals are better conductors than non-metals?

- All solids (metals and non-metals) are made of tiny particles called molecules. But, some solids conduct heat better than others. Let us put a metal and a plastic spoon in hot water.
- When both spoons receive heat energy, the particles (atoms or molecules) at the hot end of each spoon vibrate fast and bump into neighbouring particles. These particles transfer heat energy to next neighboring particles
- Particles in metals are packed more closely together than non-metals.
- Metals can transmit heat energy more readily than non-metals (wood, plastic, etc.).
- The presence of free electrons also speeds up the transfer of heat in metals.
- When the metal spoon gets heated, the free electrons gain kinetic energy and move farther towards the colder parts of the metal spoon.
- They bump into the atoms in the colder parts and transfer heat energy to them.
- In metals, heat energy is transferred from one place to another both by the vibrations of particles as well as by the movement of free electrons.
- That is why metals are good conductors of heat than non-metals(insulators).

Conduction in Liquids and Gases

- The process of conduction in liquids and gases is very slow as compared to solids (metals).
- The particles in liquids and gases are not held closely together.
- The particles have less chances to bump into other particles in liquids and even lesser in gases. That is why, the transfer of heat energy from fast-moving particles to neighbouring particles is slow.
- Water and air are bad conductors of heat.

Everyday Applications of Conduction of Heat

- Conduction plays an important role in our lives.
- Cooking utensils, electric kettle, iron, soldering iron, etc. are made of metals to conduct heat quickly. Their handles are made of plastic or wood which are bad conductors.
- Birds have feathers which keep their bodies warm because feathers are bad conductors of heat (Fig.8.5).
- Woolen clothes and blankets slow down the transfer of heat. It so happens because the wool traps air in it. The air is a bad conductor of heat.
- Ice is covered with jute rugs to reduce its melting speed.
- Jute is a bad conductor of heat.
- An insulating material (e.g. styrofoam) is filled between the double walls of a refrigerator. It reduces the transfer of heat across the walls of the refrigerator.
- Double-pan windows are used in buildings to slow the transfer of heat.
- Air between the two layers of glass acts as an insulator.

- Thermos bottles use air or a vacuum to slow the transfer of heat by

Convection

- Unlike particles of solids, particles in liquids and gases move from one place to another.
- The transfer of heat in which molecules of a medium actually move to the source of heat energy to absorb heat and then move away from it, is called **convection**.
- Convection occurs in liquids and gases only because their molecules can move freely. The molecules of a solid are held closely together. They cannot move freely, therefore, convection is not possible in solids.
- The upward and downward movement of molecules of water or air is called a **convection current**.

Winds and Ocean Currents

- We know that convection is the transfer of heat by the actual movement of theparticles in materials.
- Winds and ocean currents are examples of effects of convection.
- The heat of the Sun heats up the surface of the Earth and the air near it also gets hot. The air expands and gets lighter. So, it rises up and cool air from the neighbouring regions moves in to fill its space. The rising warm air reaches upper colder layers of the air and cools down.
- Cool heavy air sinks to the Earth in cold regions to blow again to take the place of the rising air. Thus, convection currents are setup and the wind-system goes on.
- Ocean currents are also set up due to convection of heat. Water of the hot regions of an ocean gets hot, it expands and gets lighter, but water in the colder regions remains cold and heavy.
- Hot water moves along the surface of the ocean towards the colder regions. The cold water flows below the surface of the ocean towards the hot regions. In this way, ocean currents are set up.

Convection and Gliding Flight of Birds

- Convection currents also take place in atmosphere.
- The heat from the Sun warms the air near the ground.
- The warm air expands and becomes lighter in weight.
- As warm air rises, colder air rushes in to fill its place near the ground. This process continues.
- Birds like eagles, hawks, vultures and gulls take advantage of this phenomenon. They enjoy gliding.
- During gliding flight a bird does not move its wings, but glides on air currents. A lot of energy of birds is saved during gliding

Everyday Applications of Convection Currents

- We can observe the use of convection currents in our surroundings.
- **Household ventilation** can make our house cool. The air which we breathe out is warmer and lighter. It moves up in the room to go out of the ventilators near the top side of the walls. Fresh and cool air enters the room through windows and doors.
- In a **domestic water Heater**, water is heated in the boiler by gas burner or heating coil. The hot water expands and becomes lighter in weight. This water rises and flows into the upper part of the water heater. To take the place of hot water, cold water from storage tank (cistern) falls to the lower part of the water heater to become hot. We take the hot water from the tap attached to the water heater, convection currents help in the continuous supply of hot water.
- An **air conditioner** also uses convection currents cool a room. Air conditioners are installed near to the ceiling. The fan of an air conditioner blows cool dry air. The cool air is heavier in weight, so it sinks. The warm air of the room rises because it becomes lighter in weight. The air conditioner draws this warm air to make it cool. In this way, the air circulates again and again till desired temperature is reached.

Radiation

- The transfer of heat energy from a hot body to a cold body directly, without heating the space in between the two bodies is called radiation.
- When we sit in the sun or in front of a heater, we feel warmth. Heat energy reaches us by radiation.
- This heat cannot reach us by conduction because air is a bad conductor of heat. Similarly, this heat cannot reach us by convection, as the hot air rises upward, rather than sideways.
- If we put a cardboard or a plastic sheet between us and the source of heat, we no longer feel warmth.
- So, we can say that heat from the Sun or a heater reaches us by radiation which requires no medium

Experiments on Radiation and Absorption

- Objects absorb and radiate heat at the same time.
- Whether all objects absorb and radiate heat equally.

Good and Bad Radiators and Absorbers of Heat

- Experiments have proved that good absorbers of heat are also good radiators of heat.
- Black surfaces are good absorbers and good radiators of heat, while shiny surfaces are bad absorbers and bad radiators of heat.

Everyday Applications of Radiation of Heat

- Every object emits or radiates some amount of heat. Knowledge of radiation can help us in many ways.
- When we sit beside a fire, the heat of fire reaches us by radiation.
- The cooling fins at the back of our refrigerator need to radiate its heat quickly to the surroundings. Its surface is made rough and painted black
- During hot summer days, it is advised to wear white or light-coloured clothes. White colour absorbs less heat than dark colours.
- In cold areas, a greenhouse is used for better growth of plants. Radiation from the Sun passes through the glass or plastic and warms up the soil and plants. Plants and soil absorb and emit radiation and increase the temperature in the greenhouse. Plants grow well in increased temperature of the greenhouse (Fig. 8.14).

- A blacksmith experiences all three ways of heat transfer, i.e. conduction, convection and radiation.
- The iron in the blacksmith's forge glows red as heat is transferred to the metal from the furnace. (conduction)
- The heat of the furnace warms the air in the blacksmith's shop. (convection)
- The blacksmith feels the glow of heat from the furnace. (radiation)

8.12: The Vacuum Flask

- The vacuum flask is a container which can keep hot things hot and cold things cold.
- The vacuum flask reduces the rate of transfer of heat by all the three ways, i.e. conduction, convection and radiation.
- The vacuum flask (thermos flask) is actually two thin glass or metal bottles, one inside the other
- Air between the glass walls is removed to create vacuum.
- The vacuum prevents the transfer of heat by conduction and convection.
- The walls of both bottles are coated with aluminium on the vacuum side.
- These silvered (like a mirror) and smooth glass walls prevent transfer of heat by radiation.
- The lid of the flask is made from a bad conductor such as cork or plastic only a little amount of heat is lost by conduction through the lid.
- The thin walled glass bottle is protected by fixing it in a metal or plastic container.

- Heat is a form of energy. Heat always flows from an object at higher temperature to an object at lower temperature.

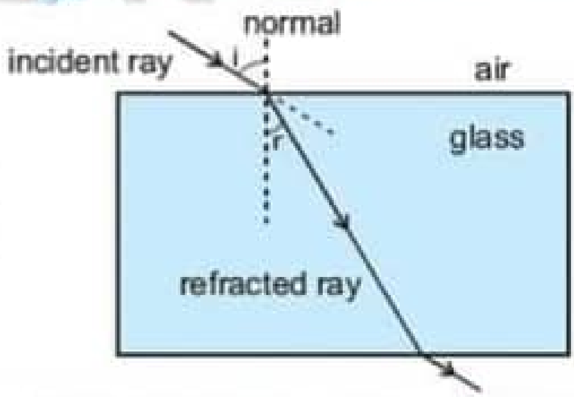
CHAPTER 9. DISPERSION OF LIGHT

- A deep tub filled with water appears less deep.
- A puddle of water on the road on a hot, sunny day
- A beautiful rainbow in the sky after rain
- All these phenomena are the result of a property of light, called refraction.

Refraction

- We know that light does not need a material medium to travel.
- Light travels at different speeds in different mediums.
- Light travels the fastest through the vacuum.
- When light passes from one transparent medium to another, it changes its speed and direction (or bends).
- This bending of light is called refraction. But, when light falls perpendicular to the surface of the medium, it does not change its direction.

- *The pencil in the glass of water looks as it has been broken at the water line. It is because of refraction of light.*

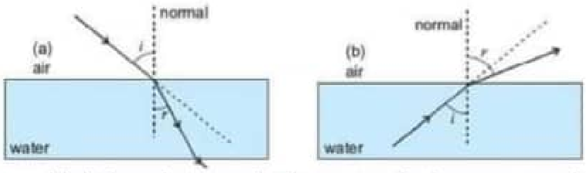


- *A light beam bends as it travels from air into glass and also from glass into air.*

Important Terms

- We can understand the term refraction with the help of the following terms:
- Incident Ray: The ray of light that travels in one medium and falls on the surface of the second medium.
- Refracted Ray: The ray of light that changes its direction in the second medium.
- Normal: An imaginary line, drawn perpendicularly on the surface of the medium at the point where incident ray falls (point of incidence).
- Angle of Incidence: The angle between the normal and the incident ray. It is denoted by '*i*'.
- Angle of Refraction: The angle between the normal and the refracted ray. It is denoted by '*r*'.
- Refraction in Different Mediums (Glass and Water)
- When light passes from air to water or glass, it bends towards the normal. The angle of incidence is greater than the angle of refraction
- $\angle i > \angle r$

- When light passes from water or glass to air, it bends away from the normal. The angle of refraction is greater than the angle of incidence
- ∠r > ∠i



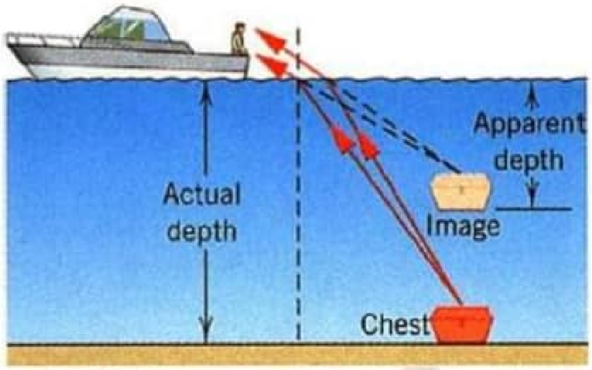
- *Light bends towards the normal when passes from air into water or glass. It bends away from the normal when passes from water or glass into air.*
- 9.3: Laws of Refraction
- There are two laws of refraction.
- The incident ray, the refracted ray and the normal at the point of incidence, all lie in the same plane.
- The ratio of the speed of light in vacuum to its speed in another medium is always
- constant.

9.3.1: Refractive Index

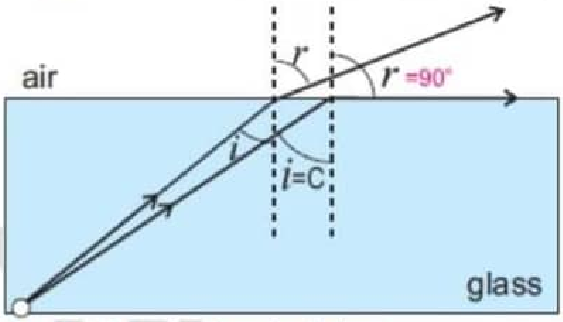
- The speed of light varies in different mediums. Some mediums cause light to bend more than others when it passes through them. The degree to which a medium can bend light is given by its refractive index.
- In terms of speed of light, we can define refractive index as, "refractive index is the ratio of the speed of light in vacuum to its speed in the medium".
- $refractive\ index\ of\ medium = \frac{speed\ of\ light\ in\ vacum}{speed\ of\ light\ in\ medium}$

Real and Apparent Depth

- Sometimes refraction of light gives us a false impression of the depth and position of objects in water or glass.
- For example, we have noticed that clear swimming pools look shallower than their actual depth. It is because of refraction of light.
- Light travels faster in air than in water. When light passes from a denser medium (water) to a rare medium (air), it bends away from the normal. When this refracted light enters our eyes, the bottom of the pool and objects lying on the bottom appear close to us than they really are
- Critical Angle
- When light rays pass from a denser medium (water or glass) to a rare medium (air), they bend away from the normal.
- The angle of refraction is greater than the angle of incidence.
- If the angle of incidence is gradually increased, a stage will come when maximum refraction occurs and the angle of refraction becomes 90o.Here the refracted ray becomes parallel to the surface of the refracting medium.
- The angle of incidence for which the angle of refraction is 90o is called the critical angle. It is denoted by 'C'.
- Critical angle for water is about 49o while for lass is 42^0.



- *Fig.9.5. It is because of the refraction of light that the chest (box) appears higher in the water than actually is.*

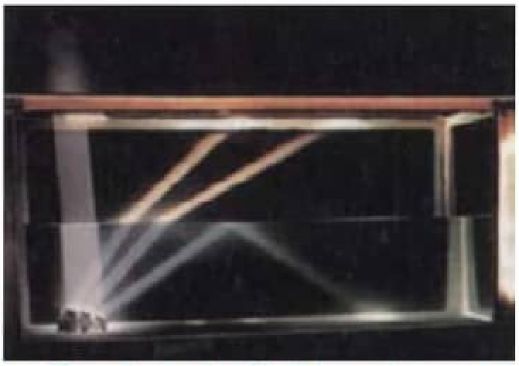


- *C is the critical angle of glass.*

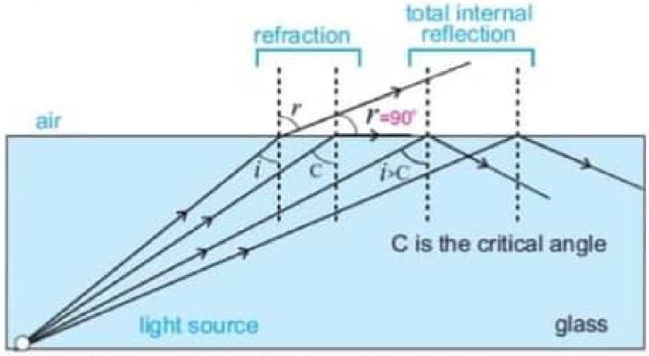
9.6: Total Internal Reflection

- When light passes from glass or water to air (denser to rarer medium), it bends away from the normal. But when angle of incidence (i) is greater than the critical angle 'C', the light rays reflect in the same denser medium. This phenomenon is called total internal reflection.
- Total internal reflection takes place only when:
- Light passes from a denser medium (water or glass) to a rare medium (air).
- The angle of incidence of all rays must be greater than the critical angle of that denser medium.
- $\angle i > \angle C$

- *The underwater reflection of the turtle is the result of total internal reflection.*



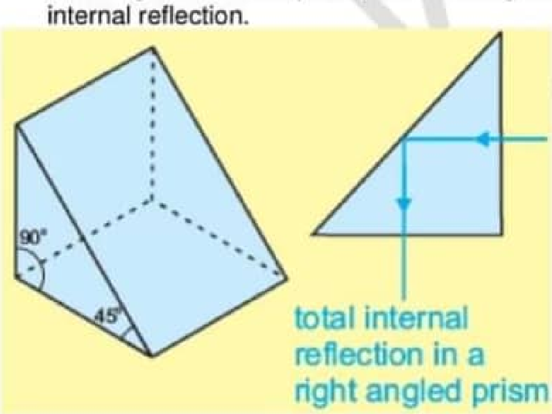
- *Once the angle of light beam becomes greater than the critical angle, it is totally reflected at the surface of the water.*



- Applications of Total Internal Reflection
- Many optical instruments use the principle of total internal reflection for their working.

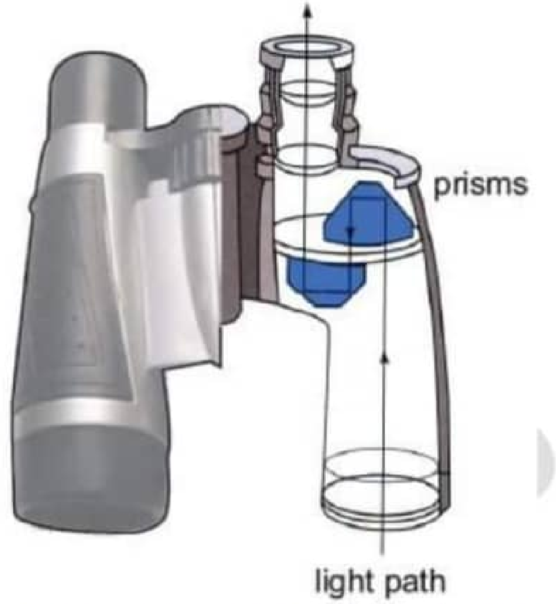
Prisms

- A prism is a block of glass with three rectangular and two triangular surfaces.
- A right angled prism has one 90° and two 45° angles. The critical angle for glass is about 42°. When light enters the prism, it will undergo total internal reflection.



Binocular

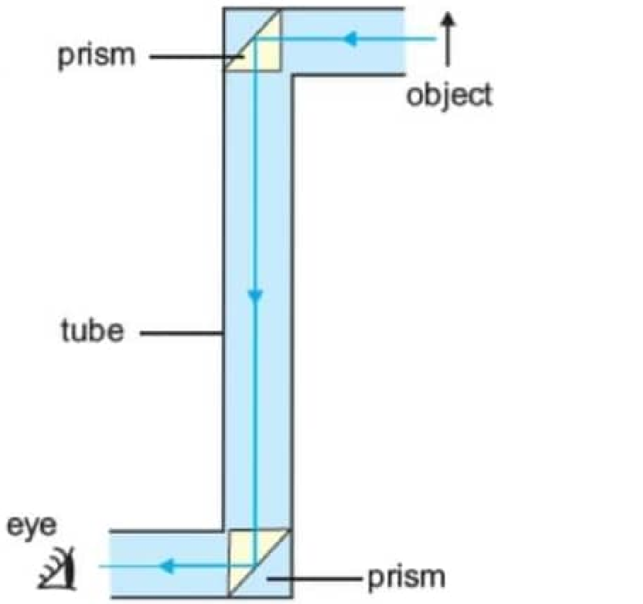
- The critical angle for glass is around 42°. When light enters a right-angled prism, it makes an angle greater than the critical angle. It causes total internal reflection to take place. A binocular uses reflecting prisms to see distant objects.



- *A binocular uses reflecting prisms to see distant objects.*

Periscope

- We can see objects which are higher than our eyes with the help of a periscope. A simple periscope consists of a tube, at the ends of which are fitted two right angled prisms. The first prism turns light coming from the object towards the second. The second prism turns it to our eyes. The prisms use the principle of total internal reflection (Fig.9.11). Periscopes are used in submarines, tanks, etc.



- *: Prisms in a periscope help to see objects which are higher than eyes.*

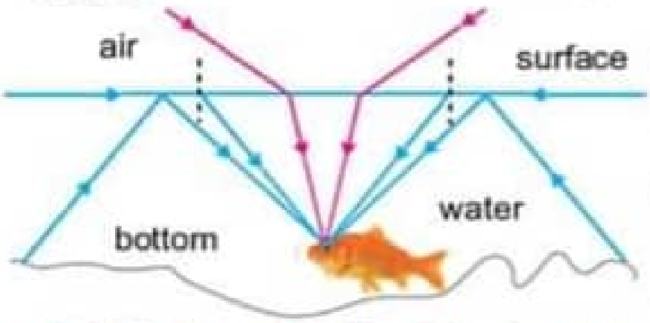
Mirages

- A Mirage is an image of some distant object which appears to us due to the refraction and total internal reflection of light.
- The air higher up is cooler than the air near the road.
- Light travels faster when it reaches the warmer air.

- The light rays bend as they travel downward due to refraction.
- Near the ground where air is even more warm, the light rays travel almost parallel to the ground but continue to bend in other direction (total internal reflection).
- When we see these bending light rays, our brain assumes that the rays have travelled in a straight line.
- These rays seem to us as reflecting from water. As a result, we see a mirage.
- Desert travelers often observe mirages.

Fish Eye View

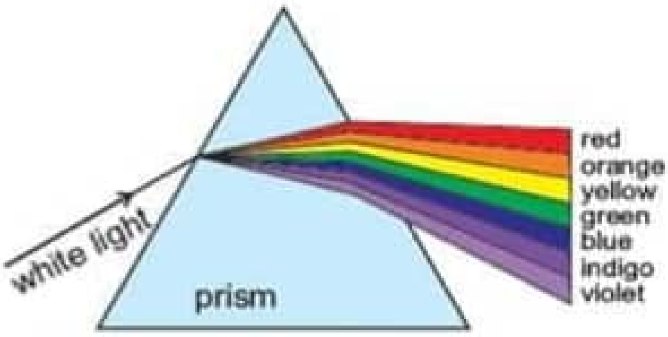
- We have studied that when light travels from one medium into another, its speed changes, which causes the light to refract at the boundary.
- As light travels from water to air, it will bend away from the perpendicular to the surface.
- When the angle of incidence is greater than 49 degrees, all the light is reflected back into the water (total internal reflection).
- When fish looks up, it will see reflected view of the sides and bottom of the pond, while directly above, it sees a compressed view of outside world due to refraction.



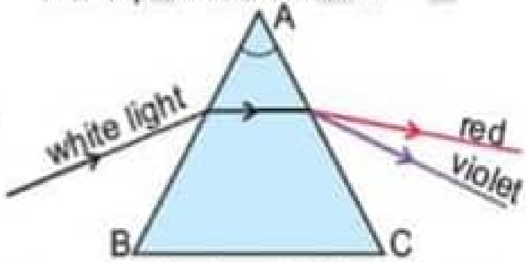
- *A fish looks the water above as a mirror due to total internal reflection.*
- The critical angle of glass is 42°.
- Total internal reflection makes light transmission over long distances possible in optical fibres.
- Optical fibres are thin transparent glass fibres in which light travels due to total internal reflection.
- These fibres are commonly used in communication, e.g. in telephone transmissions, TV programs and computers.
- An optical fibre can carry thousands of phone calls at the same time. Find other uses of optical fibres in medicines and industries.

Dispersion of Light

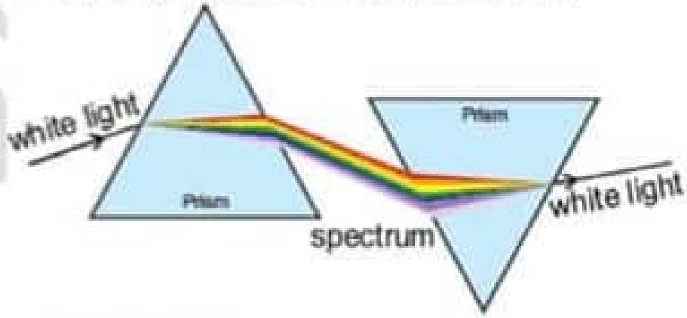
- Sunlight is often called white light, although it is a combination of different colours.
- We can see these colours in a rainbow.
- These colours are red, orange, yellow, green, blue, indigo and violet. We can also spilt white light into its colours by passing it through the prism.
- The band of seven colours obtained is called spectrum of white light.
- The splitting of white light into its component colours is called dispersion of light



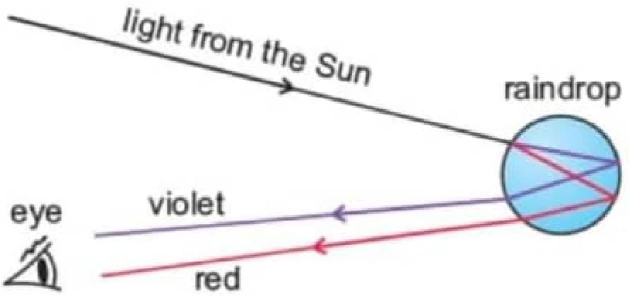
- When a beam of light enters a prism, all the colours of white light refract at different angles– it causes the white light to split into its component colours.
- Red light bends the least. Violet light bends the most and refracts by the largest angle.
-)). When this spectrum is again passed through another prism as shown in the



- Fig. 9.15(b), a beam of white light is obtained.



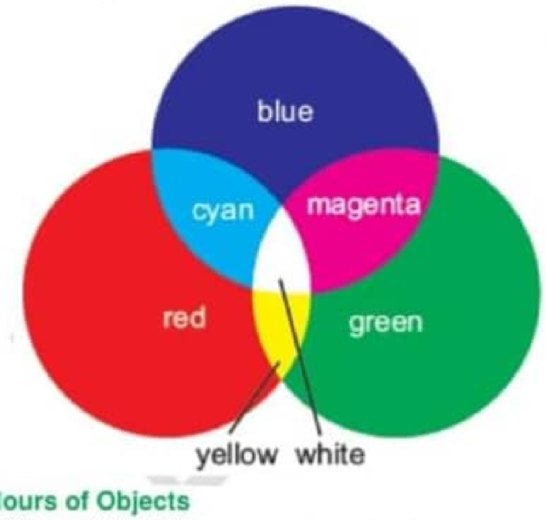
- Rainbow Formation
- A rainbow is a natural demonstration of refraction, dispersion and total internal reflection of light.
- When white light of the Sun passes through tiny rain drops suspended after rainfall, a rainbow may appear. Raindrops in the air act like tiny prisms.
- They refract and reflect the sunlight and then separate it into different colours.
- The colour scheme of rainbow is the same as in the spectrum made by the prism.
- Since red colour bends the least and violet colour bends the most from its original path, so in the rainbow, the red colour appears at the top and the violet colour appears at the bottom.
- The other colours appear in between these two colours



- *A rainbow forms when sunlight is refracted and totally reflected by tiny water droplets.*

Colours of Light

- An understanding of colours is very useful in photography and theater lightings.
- People who work with lights of different
- colours must know how to produce lights of various colours from a few basic colours. The colours that can be used to make any other colour are called primary colours.
- These are red, blue and green. We can mix the light of three primary colours to produce white light.
- Red + Blue + Green = White
- When two primary colours mix, they produce a secondary colour. Cyan, yellow and magenta are secondary colours. A colour television uses different combinations of colours.
- Red + Green = Yellow
- Red + Blue = Cyan
- Blue + Green = Magenta
- We can obtain other colours of light by mixing lights of primary and secondary colours.



Colours of Objects

- When white light shines on non-luminous objects they reflect some colours and absorb all the others.
- The colour of an object is the colour of light it reflects. A red object appears red because it reflects red colour of light and absorbs all the other colours .
- The grass of our lawn appears green as it reflects green light into our eyes.
- When all the colours of light are reflected into our eyes, the object appears white. And, when all the colours of light are absorbed by the object, it appears black.
- Black objects do not reflect any light. Objects of colours other than primary colours reflect mixture of colours.
- *The petals of rose appear red because they reflect red light. The leaves appear green because they reflect green light.*
- When light passes from a transparent medium to another, it changes speed and bends. This bending of light is called refraction.
- Refraction causes images to form in our eyes, a rainbow to take place, etc.
- When light passes through a prism, it refracts and bends at an angle. A prism can split white light into its component colours.
- Red, orange, yellow, green, blue, indigo and violet are the component colours of white light.
- The band of seven colours of light is called the spectrum of light.
- A rainbow disc has all the seven colours of light. When it is spinned, white disc is seen.
- Red, blue and green are three primary colours of light. Primary colours combine to make secondary colours of light.
- The colour of an objects is the colour of light it reflects. A red flower reflects red colour and appears red. A white surface reflects all the colours of light and appears white. A black surface reflects no colour.

CHAPTER 10 SOUND WAVES

- When we throw a stone in a pool of water, waves are produced in water.
- A wave is a disturbance that transfers energy from one place to the other.
- Waves can be produced in liquids, gases and solids.
- Many waves require some material to travel through. This material thing is called a medium. Gases (air), liquids (water), and solids(rope or a metal) all act as mediums.

What Causes Waves?

- Hold one end of a rope and move it up and down, you will produce waves in it. We see that vibrating movements of some substance can create waves.
- A vibration is a repeated to-and-fro or up-and down motion of some substance.

Waves in a pool of water

We can create waves in water by dipping our finger again and again.

Transverse and Longitudinal Waves

- There are two types of waves, i.e. transverse waves and longitudinal waves.

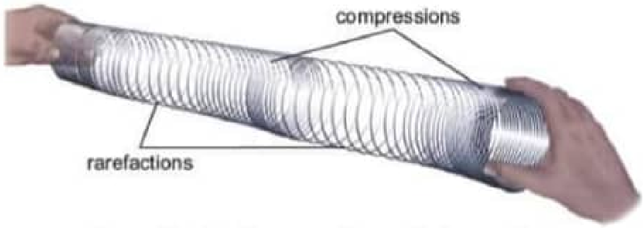
Transverse Waves

- A wave in which particles of the medium move up and down perpendicularly to the direction of the wave is called a **transverse wave**.
- Waves that are produced up and down in water are transverse waves.
- Observe transverse waves produced by the up and down movement of a rope
- The part of the transverse wave where the particles of the medium are above the normal position is called **crest**
- the part of the wave below the normal position is called **trough**.

Fig.10.3: By moving the free end of a rope up and down, we can create transverse waves.

Longitudinal Waves

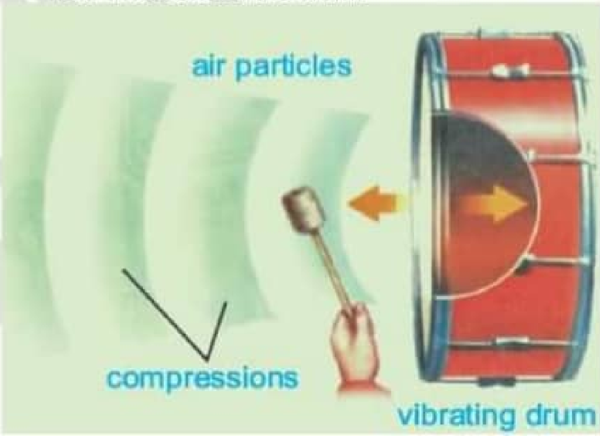
- A wave in which particles of a medium move back and forth, parallel to the direction of the wave is called a longitudinal wave.
- If we pull and push one end of the slinky spring continuously, we can produce a longitudinal wave.
- The parts of a longitudinal wave, where particles of the medium are compressed together, are called compressions.
- The parts of a longitudinal wave, where particles of the medium are spread out, are called rarefactions.
- As the wave moves, compressions and rarefactions are produced due to the back and forth motion of particles of the medium.
- Sound from a vibrating body produces longitudinal waves in air. These waves reach our ear and affect the ear drum.
- A compression and a rarefaction is combined to form a longitudinal wave.



Longitudinal waves in a slinky spring

Sound waves are longitudinal waves

- A sound wave traveling through air is a an example of a longitudinal wave.
- When a drummer beats a drum, the surface of the drum vibrates and creates a disturbance in the air beside it.
- When the drumhead moves to the left, it compresses the particles of air and create a compression. When the drumhead moves to the right, the particles of the air on the right move farther apart, creating a rarefaction.
- These compressions and rarefactions travel through the air as longitudinal waves.
- When the disturbance in the air reaches our ears, we hear the sound of the drum.

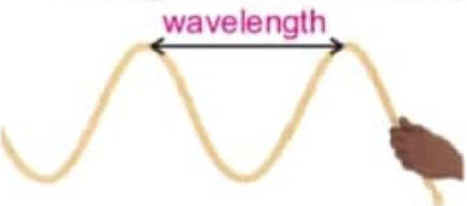


Wavelength, Speed, Amplitude and Frequency

- The basic terms to understand waves are amplitude, wavelength, frequency and speed.

Wavelength

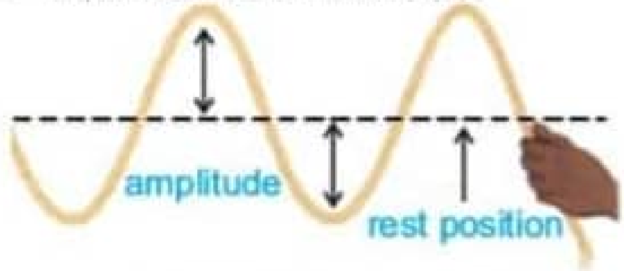
- A wavelength is the shortest distance between two adjacent crests or troughs of a transverse wave.
- For longitudinal waves, it is the distance between two adjacent compressions or rarefactions
- Wavelength is measured in metres (m).



Distance between two adjacent crests or compressions is the wavelength.

Amplitude

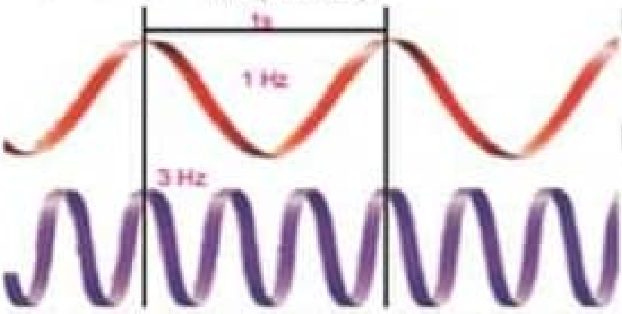
- Amplitude of a wave is the maximum distance of the particles of the medium from the rest position.
- We can also say that it is the height of a crest or depth of a trough (transverse wave) measured from the rest position.
- Amplitude is measured in metres (m).



Amplitude of a transverse wave

Frequency

- The number of vibrations produced by a vibrating body in one second is called frequency.
- Frequency is measured in units called hertz (Hz).
- When one wave passes through a point in one second the frequency is 1 wave per second or 1 hertz.
- $frequency = \frac{number\ of\ waves}{time\ (in\ seconds)}$



The wave on the bottom has a frequency three times greater than the wave on the top.

Speed

- Imagine watching a flash of lightning and thundering of cloud. First we see the flash of lightning. A few seconds later we hear thunder. This happens because sound and light travel at different speeds.
- Light travels much faster than sound. Different waves travel at different speeds.
- The distance a wave covers in unit time is called its speed.
- Speed is measured in metre per second.
- Sound travels at different speeds in different mediums.

Relationship of Speed, Wavelength and Frequency

- The speed, wavelength and frequency of a wave are related to each other by a mathematical formula.
  Speed = wavelength x frequency
- On October14, 1947, Captain Chuck Yeager of USA became the first person to fly a plane faster than the speed of sound. Fifty years later on October 15, 1997, Andy Green drove his jet-powered car at 339 metres per second. His speed was faster than the speed of sound.

Audible Frequency Range

- The word audible means 'able to be heard'. Our ears cannot hear sounds of all frequencies.
- The range of frequencies which a person can hear is known as audible frequency range.
- A healthy human ear can hear sounds of frequencies from about 20 Hz to 20,000 Hz.
- It is the audible frequency range for humans.
- Different animals have different audible frequency ranges.

Pitch and Loudness

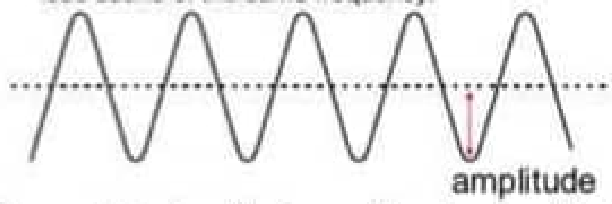
- Everyday, we hear a great variety of sounds. We enjoy some sounds.
- Some sounds are undesirable.
- Sounds produced by radio, television and musical instruments are pleasant.
- Sounds produced by machines, traffic on a road, etc. are undesirable.
- Pitch and loudness are the characteristics that help us to decide whether a sound is pleasant or not.

Pitch

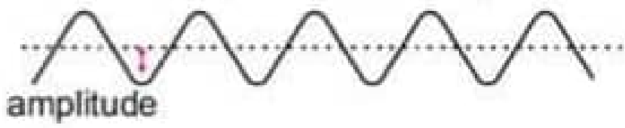
- The voice of a girl is more shrill than the voice of a boy. This difference is due to the pitch.
- A shrill sound is called a high pitch sound, whereas a less shrill sound is called a low pitch sound.
- Pitch is the shrillness or graveness of a sound.
- Pitch of the sound depends on the frequency of the sound wave.
- The higher the frequency, the higher the pitch is.

Loudness

- Sometimes, we need to shout in a louder voice. We have to use an extra energy.
- Loudness is related to the amplitude of a sound.
- The larger the amplitude, the louder the sound.
- Loudness helps us to distinguish a soft sound from a loud sound of the same frequency.



Waves of a loud amplitude sound have large amplitudes.



Waves of a soft sound have small amplitudes.

Applications of Different Sounds

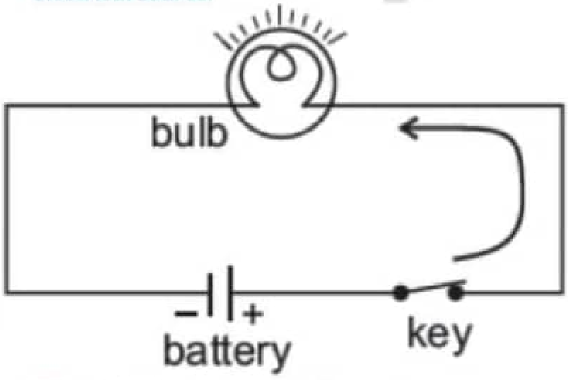
- **Making Sounds**
- Sounds are very important in our lives. We use many devices which produce different sounds

- Stereo player.
- Siren
- Smoke detector
- Doorbell
- Telephone
- Security system

CHAPTER 11 CIRCUITS AND ELECTRIC CURRENT

Flow of Current (Direction)

- The flow of charges through a conductor is called **electric current**.
- Charges travel from one pole to the other pole of an electrical source (battery)
- It has been proved that only negatively charged electrons move from one place to the other.
- Positively charged protons do not move.
- In early days, before the discovery of electrons, scientists guessed wrongly that electric current was the flow of positive charges from the positive pole of the battery to the negative pole. Scientists still adopt this idea and they have called it as **conventional current.**
- The unit for electric current is **ampere** (A). Other smaller units are milliampere (mA) and micro ampere (m A).
- Electric current is measured by an **ammeter.**
- An **electric circuit** is a complete path along which charges flow.
- A key (switch) can open or close a circuit.
- Electric current only flows through a closed circuit.
- *Electric current flows from one pole to the other of an electrical source.*



- *These and many other appliances in our homes use electric current.*

- The materials which allow electric current to pass through them are called conductors.
- Metals, such as copper, silver, iron and aluminium are good conductors.
- The materials which do not conduct electricity are called insulators.
- Rubber, glass, sand, plastic and wood are insulators.

Types of Electric Circuits

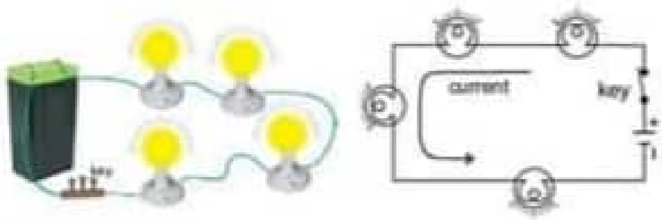
- There are several kinds of circuits. But here we shall discuss its two main types, i.e. **series circuits** and **parallel circuits.**

Series Circuits

- If all the components are connected one after another in a single loop, then it is a **series circuit.**
- In a series circuit, there is only one path for the current to flow.
- The amount of current which flows through each component (bulb) of the circuit is the same.

Disadvantages of the Series Circuits

- There is only one path for the current to flow. A break at any part of the circuit stops the flow of current in the whole circuit.

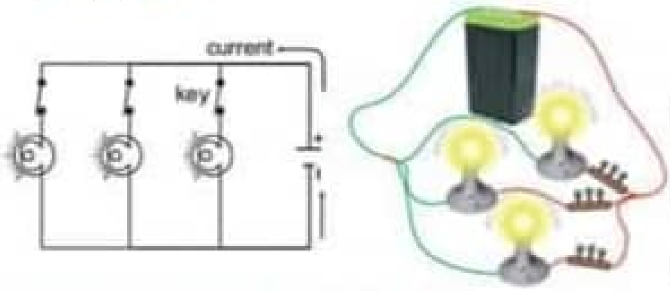


Parallel Circuits

- If the components are connected in two or more loops, then it is a parallel circuit.
- In a **parallel circuit**, there are more than one paths for the current to flow.
- The current flowing through different branches of a parallel circuit may be the same or different. But the current in each branch is less than the total current flowing out from the electrical source (battery).

Advantage of a Parallel Circuit Over a Series Circuit

- A parallel circuit has an advantage over a series circuit.
- There are more than one path for the current to flow. A break in any branch of the circuit stops the current flowing through that branch only.
- *In a parallel circuit, there are more than one path for the current to flow.*

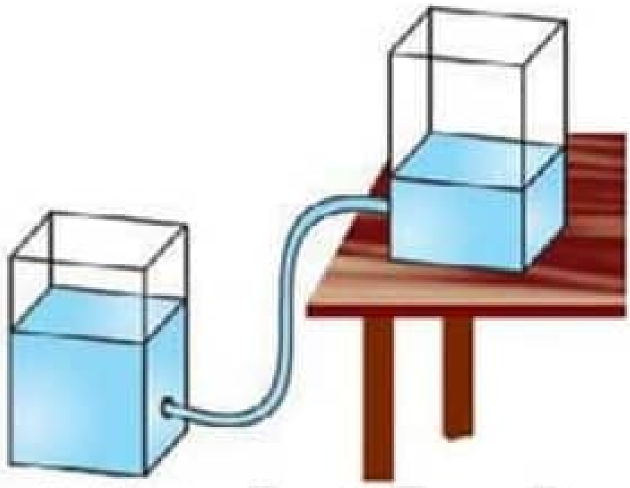


Energy Transfer in an Electrical Circuit

- Electricity brings energy to our homes from a power station.
- The energy of moving electric charges within a circuit is called electrical energy.
- As charges flow in a circuit, some electrical energy always changes to heat energy.
- A light bulb transforms electrical energy to light energy.
- Electric bells and stereo players transform electrical energy to sound energy.
- A heater gives us heat by using electrical energy. A fan converts electrical energy into mechanical energy.

How Do Charges Flow?

- The flow of electrons through a conductor (wire) can be compared to the flow of water in a pipe.
- The water flows from higher level to the lower level. The potential energy of water in the can at a higher level causes the water to flow. Similarly, current flows from higher electric potential to lower electric potential.



- The difference of potential between two points in a circuit or battery is called **potential difference** or **voltage.**
- Potential difference causes the charges to move through the conductor.
- Potential difference is measured in volts (V).
- Charges will flow as long as there is a potential difference between the two points.
- Every battery has its potential difference printed on it.
- For example, a dry cell carries 1.5V.
- Other units of volt are millivolts (mV) and kilovolts (kV).
- A **voltmeter** is used to measure potential difference.

Resistance

- Electric current flows through some objects better than others .
- The measurement of how well something conducts electricity is its resistance.
- **Resistance** is the hindrance to the flow of current. During its journey through an electric circuit, the charges collide countless times with atoms within the conductor (wire). These collisions result in the hindrance to the flow of the current (resistance).
- The resistance of a wire depends on **length of the wire** and **thickness of the wire.**
- Recall the flow of water in a pipe! A long pipe resists the flow of water more than a short pipe and a thin pipe resists the flow of water more than a wide pipe. Long wires have more resistance than short wires. Thin wires have more resistance than thick wires.
- The unit of resistance is ohm.
- *Water flows more easily through a short, wide pipe than through a long, narrow pipe.*
- *Similarly, electrons flow more easily through short and thick wires*

Relationship between Voltage and Resistance

- A mathematical equation shows the relationship between voltage and resistance.

$$resistance = \frac{voltage}{current}$$

  The above equation shows that resistance is equal to the voltage divided by the current. It is called **Ohm's Law.**
- In 1827, a German scientist George Simon Ohm discovered the relationship between the voltage and resistance in an electric circuit.

Measuring Current, Voltage and Resistance

- Following meters are used to measure current, voltage and resistance of an electric circuit:
- An **ammeter** is the device to measure the amount of current in an electric circuit It is connected to the circuit in series so that the full current passes through it.
- An ammeter does not change the amount of the current in a circuit because it has very low resistance.
- A **voltmeter** is the device to measure the voltage (potential difference) in a circuit). It is connected in parallel with the circuit. The current does not flow through a voltmeter because it has very high resistance.
- A **multimeter** can measure resistance, voltage and small currents.

Multimeter *Voltmeter* *Ammeter*

Electrical Power

- All electrical devices such as fans, blenders, computers, etc. convert electrical energy into other forms of energy.
- Electrical power is the rate at which a device converts electrical energy into another form of energy.
- Its unit is watt (W).

Kilowatt-hour (kWh)

- Our electricity bill shows the amount of energy we Consume during one month.
- It is taken as kilowatt-hour.
- One kilowatt-hour is 1 unit on the electricity meter.
- One **kilowatt-hour (kWh)** is the amount of energy used up when an electrical appliance of 1,000 watt works for 1 hour.

Effects of an Electric Current

- We cannot see the electrical energy flowing in the circuit. But if any of the following three things happen, we say that electricity is flowing.

Heating Effect of Current

- When electric current flows through a metal wire, it makes it hot. Light is also produced when a wire becomes very hot. We use many appliances in our homes that convert electric current into heat.

Chemical Effect of Current

- An electric current can chemically affect the materials particularly in molten or solution form. When a current flows through a solution, it can break up the solution into its components. This process is called **electrolysis.**
- Electricity is also used to coat a metal object with a thin layer of another metal. This process is called **electroplating.**
- The rims of bicycles are nickel-plated.

Magnetic Effect of Current

- An electric current can also produce magnetic effect in a metal wire.
- A coil of wire around a piece of iron behaves like a bar magnet when an electric current is passed through it. Such magnets are called **electromagnets.**
- An electromagnet loses its magnetism when the current stops flowing through it.
- Electromagnets present in the earpieces of your telephone convert electric signals into sound.
- Electromagnets are also used in electric motors.

Why is Electricity Dangerous

- Electricity is a part of our everyday life, but sometimes it can be dangerous. An electric shock is a lot painful and dangerous.
- If we follow these safety rules, we would be safe and sound:
  - Don't touch an electric wire which has fallen from power lines.
  - Never touch electrical appliances with wet hands.
  - Don't enter any metal object into electric sockets.
  - Don't overload power sockets. Overloaded sockets can cause fire.
  - If a person has been electrocuted, don't touch the body of that person. Use a non metallic object to move the victim away from the electric wire

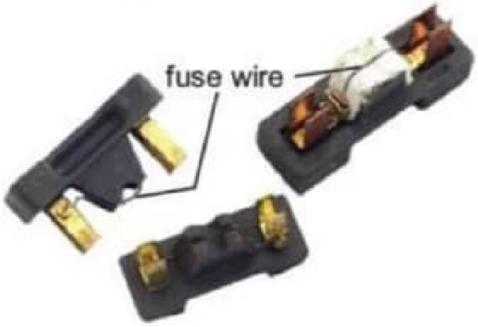
Electricity and Safety

- By taking precautionary measures we can use electricity quite safely.

Fuses

- A fuse is a piece of thin conducting wire connected in the path of a live wire.

- It gets heated up and melts on passing of a very large amount of current.
- Fuses are used to protect houses against short circuits and overloading.



MCBs (Miniature Circuit Breakers)

- Replacing the fuse again and again is not a pleasant experience. So, engineers have developed the alternatives of fuses,i.e. miniature circuit breakers (MCBs)
- An **MCB** is a small electromagnet switch that works like a fuse but it does not blow out.
- It just breaks the circuit by tripping when a current more than its rating passes through it .

Earth Wires

- Additional earth wires protect us from electric shocks.
- If a short circuiting occurs in a device, current will flow directly into the earth through a low-resistance earth wire.
- In this way, a person who touches a faulty device will be protected. An earth wire is buried in the ground.

Three-pin Plug

- In three pin plug, two pins connect the appliance to the main supply while the third pin connects the metal cover of an electric appliance to the Earth wire.
- In case of short circuiting, this third pin helps in sending the large amount of current into the ground.

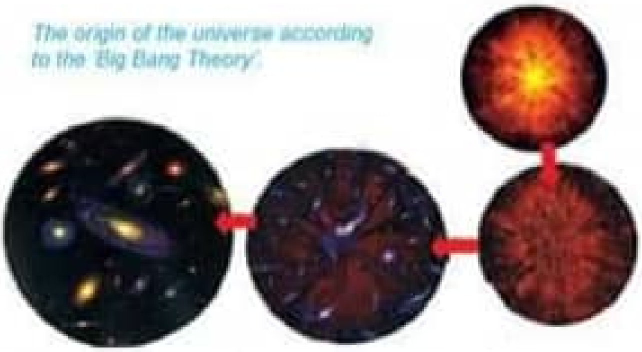
ELCB (Earth Leakage Circuit Breaker)

- An earth leakage circuit breaker (ELCB) is a safety device used in electrical installations to prevent a shock.
- An ELCB is an electromagnetic switch. It quickly turns off the power when the current flowing through the earth wire exceeds the limit.
- If someone tries to use a faulty electric appliance, an ELCB breaks the circuit at once.

CHAPTER 12 INVESTIGATING THE SPACE

- We know that our solar system is a part of the universe.
- The universe is immensely vast.
- According to space scientists the universe is expanding and there are more than 200,000,000,000 billion stars in the universe.
- The universe is all of space and everything in it. Most of the universe is empty space. Our solar system is an extremely small part of the universe. Many theories are given to explain the origin of the universe. These theories are results of human efforts in understanding the nature and origin of the universe.
- According to Islam and other Ibrahimic religions, universe was created by Allah (Almighty).
- Scientists have been presenting different theories of creation of the universe from time to time. One ofthese theories is "The Big Bang Theory". According to this theory:
- About 10 to 20 billion years ago, the universe was packed into one giant fireball. Then a tremendous explosion started the expansion of the universe.
- This extraordinary explosion is known as the Big Bang. This explosion hurled matter and energy in all directions.

The origin of the universe according to the 'Big Bang Theory'.



- After the Big Bang, the universe assumed the form of huge clouds of extremely hot, expanding and contracting gases. With the passage of time, the matter cooled: the force of gravity pulled together the particles of matter to form stars and galaxies
- The Big Bang theory was first proposed in 1927 by a priest, George Lamaitre of Belgium. This theory was supported by the discoveries of Edwin Hubble and Nobel Prize-winning scientists Arno Penzias and Robert Wilson.
- Edwin Hubble found experimental evidence to support The Big Bang Theory. He found that distant galaxies in every direction are going away from us with a very high speed. This observation is acceptable if the universe began in a huge explosion.
- The Big Bang Theory also predicts the existence of cosmic background radiation (the glow left over from the explosion itself).
- This radiation was discovered in 1964 by Arno Penzias and Robert Wilson. They later won the Nobel Prize for this discovery. Although the Big Bang Theory is widely accepted, it probably will never be proved. It cannot answer many questions about the occurrence of the Big Bang.
- The study of the Sun, Moon, stars and other objects in space is astronomy. An astronomer studies the space objects.

Stars, Galaxies, Milky Way and Star Distances

- On a clear night we can see a cloudy band that stretches North to South across the sky.
- we are seeing part of our own galaxy, the Milky Way. There are countless stars in our galaxy.
- We cannot see our galaxy as a whole, but scientists can see many other galaxies in the sky.

Stars

- We see many twinkling lights in the night sky. Some of these lights come from objects in space called stars.
- The Sun is also a star.
- Beyond the solar system, billions and billions of stars are present in space.
- Every star is a ball of glowing gases which emits energy in the form of heat and light.
- Astronomers say that our Sun is a medium-sized star.
- Some stars are much larger and some are smaller than our Sun.

Colours of Stars

- We know that stars emit heat and light in different amounts, so stars have different temperatures.
- The colour of a star is related to its temperature .
- The coolest stars have about 2800°C temperature at their surfaces and appear red.
- The hottest stars have 28000°C or higher temperatures and look blue.
- The stars with in-between temperatures have orange, yellow and white colours.
- The Sun is a yellow star. It has a temperature of 5,500 to 6000°C at its surface.
- Stars that are a little colder than the Sun look orange. Stars that are a little hotter than the Sun appear white.

Brightness of Stars

- The brightness of a star depends on two factors:
- Distance of the star from the Earth
- Amount of energy the star emits
- Imagine that you are looking at two stars that are exactly the same distance from the Earth.
- The star which emits greater amount of energy will seem brighter than the other.

Star Distances

- The stars are very far away from us.
- They are also at great distances from each other.
- Distances between stars are so great that these cannot be measured in kilometres. Instead, we use lightyears to express the distance in the universe.
- A light-year is a measure of distance that light covers in one year with a speed of 300,000 kilometres per second. It seems that a light-year is a very long distance.
- The Sun is our closest star in our galaxy.
- The next closest star Proxima Centauri is 4.2 light-years away from us.
- We can also say that light of this star will take 4.2 years to reach the Earth.

Galaxies

- We have learnt that after the Big Bang the universe assumed the form of huge clouds.
- These clouds of gases and dust formed stars.
- A galaxy is a very large group of stars, nebulae, gases, dust and planets.
- A galaxy may contain billions of stars. Astronomers have used special instruments to identify about one billion galaxies.
- Our solar system is the part of the Milky Way galaxy.
- There are many types of galaxies in the universe. Scientists classify galaxies in three main types on the basis of shape

Spiral Galaxies

- A galaxy that has a flat disklike shape with a bulge in the centre is called a spiral galaxy.
- Spiral galaxies may have a few or many spiral orcurved arms.
- A large amount of dust and gases is present in these galaxies.

- The Milky Way and Andromeda are spiral galaxies. The Milky Way galaxy contains 100 to 200 billion stars.
- The Sun is about 30,000 light-years away from its centre.
- The Milky Way galaxy is moving with a speed of 2200,000 kilometres per hour in space.
- Andromeda is about 2,250,000 light-years away from the Milky Way galaxy. It is our neighbouring galaxy.

Elliptical Galaxies

- These are oval shaped galaxies.
- These galaxies do not rotate as spiral galaxies around their axis.
- An elliptical galaxy contains less amounts of dust and gases as compared to a spiral galaxy.
- Trillions of stars may be present in an elliptical galaxy.
- New stars cannot form in most elliptical galaxies. Most of them contain only old stars.
- *An Elliptical Galaxy*

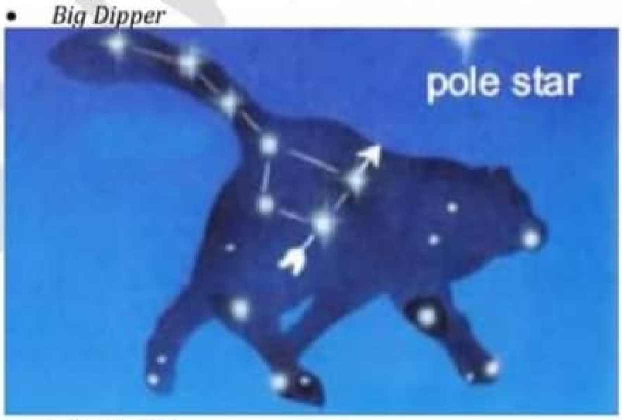
- *.An Elliptical Galaxy*

Irregular Galaxies

- These galaxies have no definite shape
- The stars in an irregular galaxy do not appear to be grouped in any set shape.
- These galaxies have many shapes and sizes.
- The Clouds of Magellan, is an irregular galaxy.
- It is a very small galaxy near the Milky Way.
- These galaxies are not very common.

Constellations

- If we look at the sky in a night full of stars, we may see certain patterns of stars. These star patterns are constellations.
- A constellation is a group of stars with a definite pattern or arrangement. Each constellation has a different pattern.
- Each constellation is found in a certain place in the sky.
- Constellations were very important to people long ago.
- Those people used the night sky to tell time and seasons.
- Crop planting, festivals and other events were planned according to the movement of the stars in constellations.
- People long ago named the star patterns they saw for objects, animals or famous people.
- People also made strange stories about constellations.
- We can observe many constellations in the night sky.
- The Big Dipper is a famous constellation.
- There are seven visible stars in the Big Dipper. Four stars make the bowl of the Big Dipper while three stars form the handle.
- The two bright stars on the end of the Big Dipper's bowl point to the Pole Star. This star helps in finding directions.
- Cassiopeia is a constellation that seems to move around the Pole Star all the year.
- Cassiopeia is on the opposite side of Pole Star from the Big Dipper and about the same distance away.
- The five brightest stars in Cassiopeia form the shape of capital letter M or W. People long ago thought this star pattern looked like a queen sitting on her throne
- *Big Dipper*



- *: Cassiopeia*

The Life of Stars

- Science has told us that the universe is finite, with a beginning, a middle and a future.
- Stars have life cycles too. A star is also born, changes, and then dies.
- The life span of a star is measured in billions of years.

- We have studied that great clouds of gasses and dust are present in galaxies.
- Each of these clouds is called a nebula.
- Stars are born in nebulae (singular nebula). A nebula collects more dust and gas during its travel through space.The gas and dust particles are packed into a hot spinning ball of matter. Such a ball of hot matter is called a protostar.
- With the passage of time, a protostar becomes hot enough to produce great amount of energy. At this stage a protostar is called a star.
- A star like the Sun emits light and heat all the time.
- *Scientists have observed protostars and young stars within the Horsehead nebula.*

Death of a Star

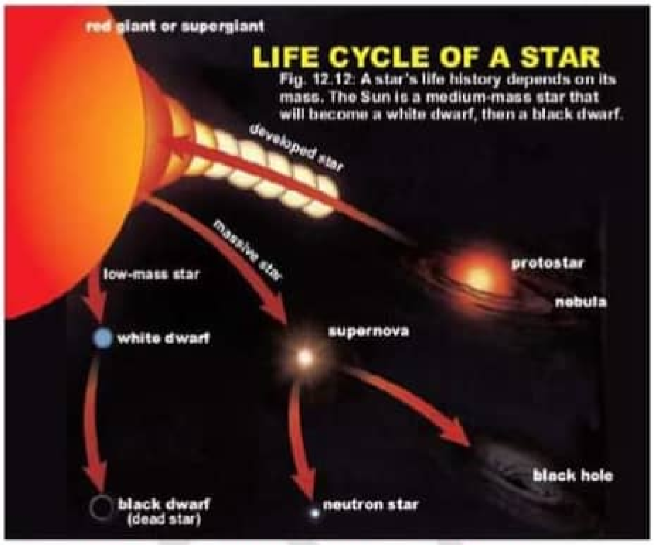
- The matter of a star is converting into energy.
- This radiant energy is released into space.
- Our star (the Sun) is dying.

Red Giant Stage

- Our star (the Sun) has passed five billion years while emitting energy.
- After the next five billion years, the hydrogen in the core of the Sun may be used up.
- The Sun will start to collapse. Its core will become denser and hotter and the Sun will swell in size. It will become a red giant.
- The Sun will be a red giant for only about 500 million years.

Dwarf Stage

- By and by the Sun in the form of red giant will cool and gravity will make it collapse inward.
- Our star will become a white dwarf at this stage.
- Eventually, the Sun will become a burn-out black chunk of very dense matter.
- It will not emit light any more. This last stage of a star's life is called a black dwarf.



Formation of Black Holes (Life of a Massive Star)

- Stars more than six times as massive as our Sun are called massive stars.
- A massive star has short lifespan than the Sun or other low-mass stars. Hydrogen in the core of a massive star is used up with a much fast speed.
- After only 50 to 100 million years, no hydrogen is left in the core of a massive star. At this time, the core collapses and the star becomes 1000 times greater than its original size. It is now called a supergiant.
- With the passage of time the supergiant becomes so dense that it cannot bear the pressure of outer layers. The outer layers crash inward with a tremendous explosion, called supernova.
- At the time of supernova, the light of the star becomes much more than all other stars of the galaxy. Great shells of gases fly off the star. Only the tiny core of the star remains left. This core contains only neutrons, so it is called a neutron star.
- It is extremely dense.
- Some times after the supernova explosion the massive star becomes a black hole.
- A black hole is so dense that nothing can escape from it due to its very strong gravity.
- Even light cannot escape from a black hole and it is no more glowing.
- In fact the black hole is the last stage of the life cycle of a massive star.

Looking at Stars

- People have looked at the stars for thousands of years. A telescope is a device that makes a far away object appear very close
- Many more stars can be seen with the telescope than with the unaided eye.
- A simple telescope has two lenses.
- The objective lens collects light from a distant object and brings that light, or image, to a point or focus.
- An eyepiece lens takes the light from the objective lens and magnifies it.

Safety Tips for Observing the Sun

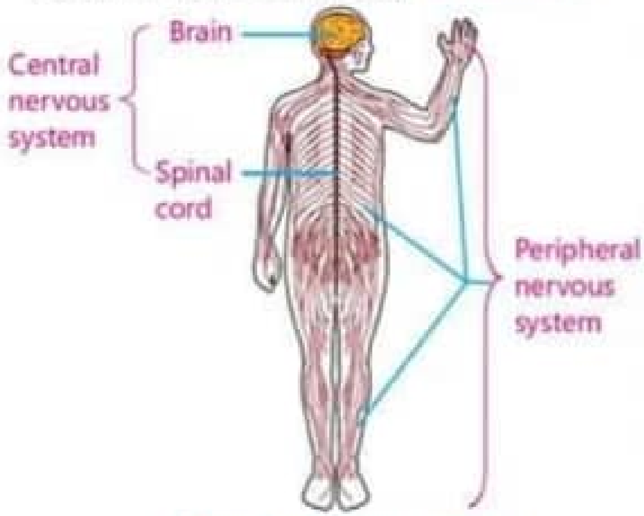
- The Sun emits dangerous radiation. Viewing directly into the Sun can damage our eye sight. Make sure the safety of your eye before viewing the Sun.
- A pinhole or small opening is used to view the image of the Sun on a screen placed a half metre or more beyond the opening.
- Use two or three sheets of X-Rays film for viewing the Sun.
- Remember! No filter is safe for use with any optical device, i.e. telescope, binoculars, etc.

Class 8th General Science

CHAPTER 1 HUMAN ORGAN SYSTEMS

Nervous System

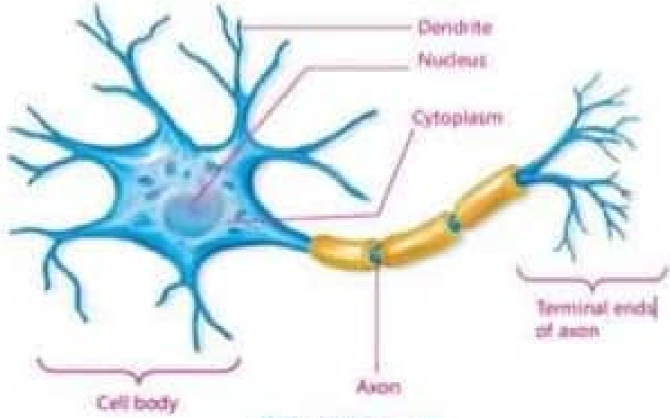
- There is an organ system in our body which carries messages form one part of the body to another and coordinates body functions. This system is called nervous system.
- Human nervous system consists ofcentral nervous system (CNS) andperipheral nervous system (PNS).
- The central nervous system is composed of brain and spinal cord.
- Peripheral nervous system consists of a network of nerves which connect the central nervous system to all parts of the body.



Human nervous system

Neuron or Nerve Cell

- Neuron or nerve cell is the basic structural and functional unit of the nervous system.
- All parts of the nervous system, i.e., brain, spinal cord and nerves are made up of neurons.
- Neurons transmit messages in the form of electrochemical waves called nerve impulses
- The part of a neuron which contains nucleus and most of the cytoplasm is called cell body. The fine projections of the cell body which receive messages are called dendrites.
- A long projection of the cell body which conducts messages away from the cell body is called axon Terminal ends of the axons transmit the messages to the next cells.



Nerve cell or neuron

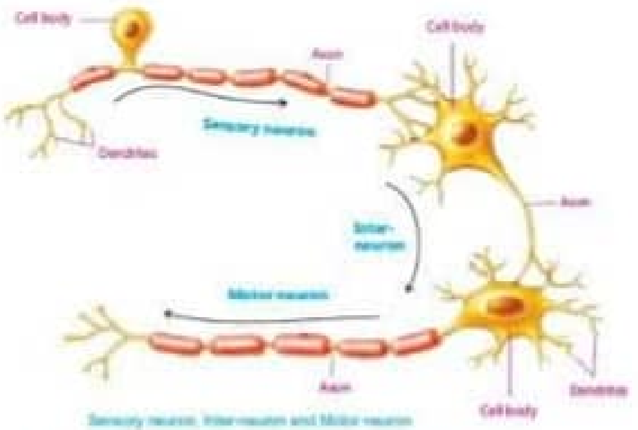
- Impulses may travel as fast as 150 metre per second or as slow as 0.2 metre per second

Nerve

- A nerve is cable-like bundle of axons enclosed in a common sheath.
- Nerve transmits messages from one part of body to another.

Types of Neurons

- On the basis of their functions, neurons are of three types, i.e. sensory neurons, motor neurons and inter-neurons.
- Sensory neurons carry nerve impulses from sense organs (ears, eyes, skin, tongue, nose, etc.) to the central nervous system.
- Motor neurons carry nerve impulses from central nervous system to effectors (muscles and glands), i.e., the parts which respond.
- Inter-neurons are present in central nervous system (brain and spinal cord). They form a link between sensory and motor neurons



Central Nervous System(CNS)

- Central nervous system acts as a control centre of the whole nervous system.

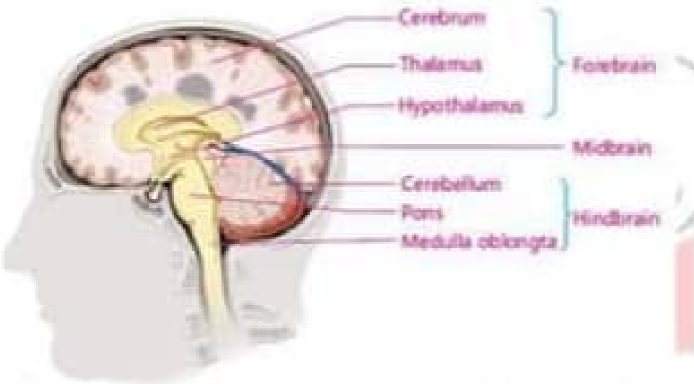
- It comprises brain and spinal cord.

Brain

- Human brain is enclosed in a bony skull called cranium, and consists of billions of inter-neurons. It is divided into the following parts.

Forebrain

- A Forebrain is the largest part of the brain.
- It consists of three main parts, i.e., cerebrum,thalamus and hypothalamus.
- Cerebrum is the topmost and the largest part of thebrain. It is divided into right and left cerebral hemispheres.
- Cerebrum controls manyactions like thinking, feelings, emotions, seeing, hearing, perceptions,memory,speech, decision making, etc.Inside cerebrum there is small structure called thalamus. I t controls many sensory functions.
- Hypothalamus lies at the base of thalamus. It controls body temperature,hunger and thirst.



Section of skull showing different parts of human brain

2 Midbrain

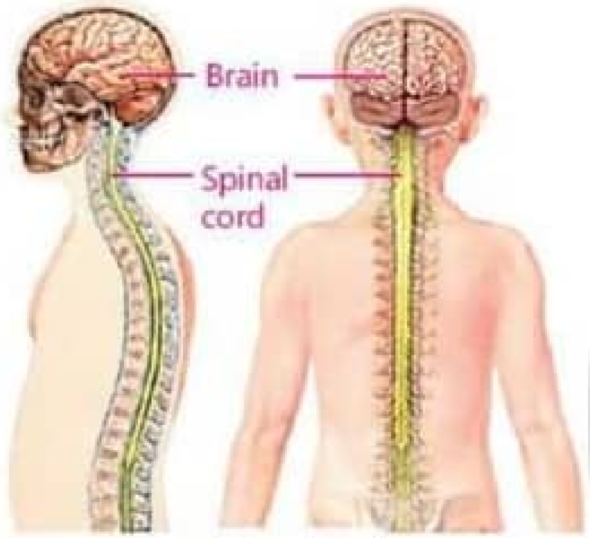
- Midbrain is a small part of the brain which is present below the cerebrum.
- It receives information from sense organs which is then passed on appropriate part of the forebrain.

Hindbrain

- Hindbrain consists of three parts, i.e., cerebellum, pons and medulla oblongata.
- Cerebellum lies under the back part of the cerebrum. It acts as a controller for maintaining the body balance and making precise and accurate movements.
- Pons is an oval structure present beneath midbrain. It controls many functions like sleep, swallowing, equilibrium and taste, etc.
- Medulla oblongata forms the posterior part of the brain where it is connected with the spinal cord. Medulla oblongata controls heartbeat, breathing and digestion, etc.
- Medulla oblongata keeps on working when rest of the brain goes to sleep.

Spinal Cord

- Spinal cord is an extension of medulla oblongata.
- It runs backwards inside the backbone up to its lower end.
- It is also made up of inter-neurons.
- Spinal cord creates a link between brain and different body parts.
- It also controls some reflex actions (immediate and involuntary actions) and some other involuntary actions.



Spinal cord

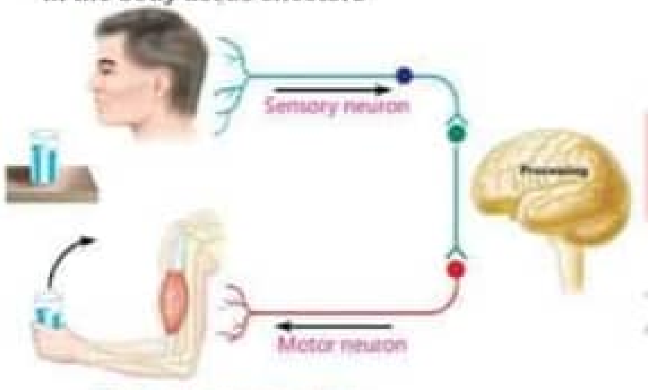
1.1.2 Peripheral Nervous System

- Peripheral nervous system (PNS) consists of a network of nerves which are spread in the body to connect all the body parts to the central nervous system (brain and spinal cord).
- The nerves which arise from brain are called cranial nerves. The nerves which arise from spinal cord are called spinal nerves.
- There are 12 pairs of cranial nerves and 31 pairs of spinal nerves in human body.

1.1.3 Working Model of the Nervous System

- Nervous system coordinates all body functions.
- It also detects the changes in environment and produces response to the changes.
- The working of the nervous system has been depicted.
- Any change in the environment (external or internal) that can be detected by a receptor to initiate a nerve impulse is called stimulus (Plural: stimuli).

- Heat, cold, pressure, sound waves, etc. are the examples of stimuli.
- The special organs, tissues or cells which detect stimuli are called receptors.
- The sensory neurons carry the messages regarding stimuli in the form of nerve impulses from receptors to central nervous system.
- The central nervous system processes the messages and transmits the nerve impulses to motor neurons.
- The motor neurons carry the nerve impulses to the parts of the body which produce responses. Such parts are called effectors. Muscles and glands in the body act as effectors



Function of nervous system

1.1.4 Actions Controlled by the Nervous System

Voluntary Actions

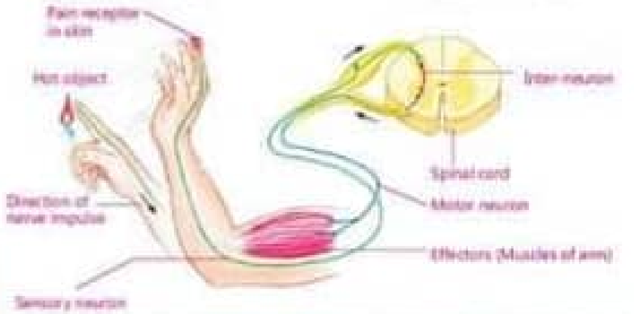
- The body actions which are performed under conscious control, i.e., which are done after thinking over them are called voluntary actions.
- For example; speaking, eating, reading, walking, running, clapping, etc., are voluntary actions.

Involuntary Actions

- The body actions which are performed without involvement of thinking process are called involuntary actions.
- Involuntary actions are not performed under conscious control.
- Heartbeat, breathing, blinking of eyes, movement of small intestine, etc., are the examples of involuntary actions.

1.2 Reflex Action

- An immediate and involuntary response to a stimulus is called reflex action.
- Quick pulling of hand just after touching the hot object is a common example of reflex action.
- In this example of reflex action, temperature of hot object is a stimulus which is received by the cells (receptors) of the skin. A nerve impulse is created in the sensory neuron present in skin. The nerve impulse is carried by the sensory neuron to the spinal cord. The inter-neuron of the spinal cord transmits the impulse to the motor neuron. The motor neuron carries the impulse to the arm muscles (effectors). The arm muscles contract and the hand is pulled back. The pathway of nerve impulses which complete a reflex action is called reflex arc. It consists of receptor, a sensory neuron, an inter-neuron, a motor neuron and effectors.



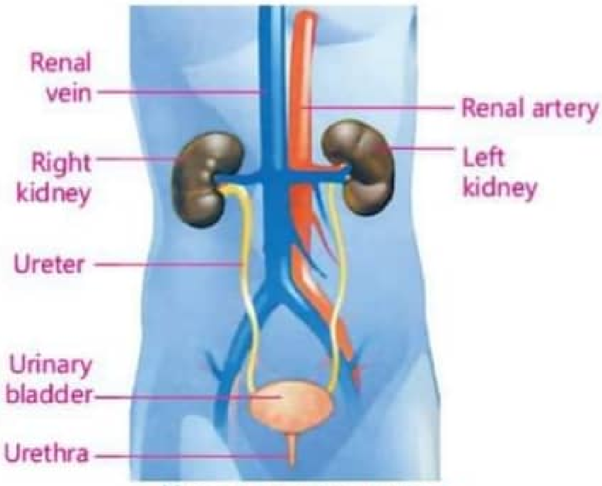
Reflex arc representing reflex action. Touching a hot object (flame in this example) results in immediate withdrawal of hand through contraction of muscles of arm.

1.3 Excretory System

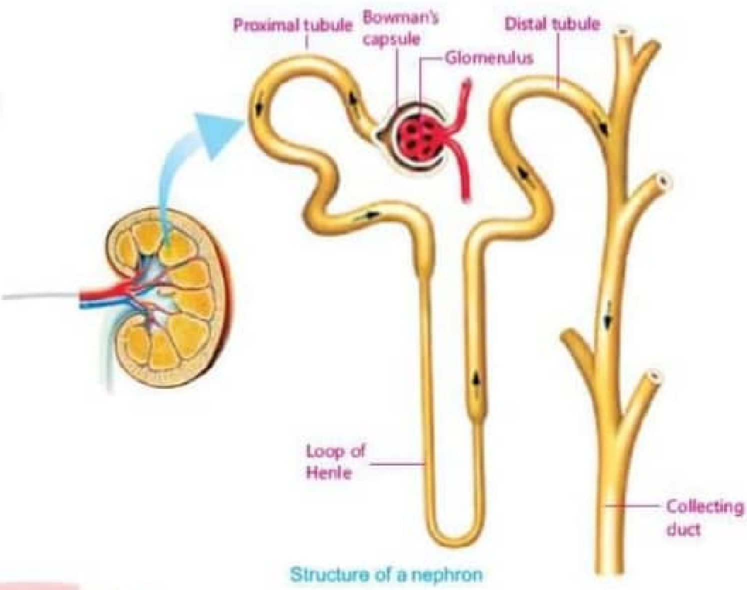
- As a result of breakdown of various food items and other chemical components of the body, nitrogenous waste matter is produced, which must be immediately removed from the body.
- Waste products in the body also include nitrogenous materials and other salts. Accumulation of waste materials in the body is dangerous and therefore must be removed from the body.
- The removal of nitrogenous waste materials from the body is called excretion.
- Nitrogenous materials, extra water and salts are removed by the excretory system.
- Some extra salts are also removed through skin during perspiration.
- Human excretory system consists of one pair of kidneys and associated structures, i.e. two ureters, a urinary bladder and a urethra

1.3.1 Kidneys and Associated Structures

- Human body has two dark brown,bean-shaped kidneys in the abdominal region, one on either side of the vertebral column.
- The right kidney is a little lower than the left one.
- The outer surface of kidney is convex while the inner surface is concave.
- A tube which arises from each kidney and enters the urinary bladder is called ureter. It transports urine from kidneys to urinary bladder.
- Urinary bladder is a muscular sac which collects urine from both ureters.
- A fine tube through which urine is released from urinary bladder to the outside is called Urethra.



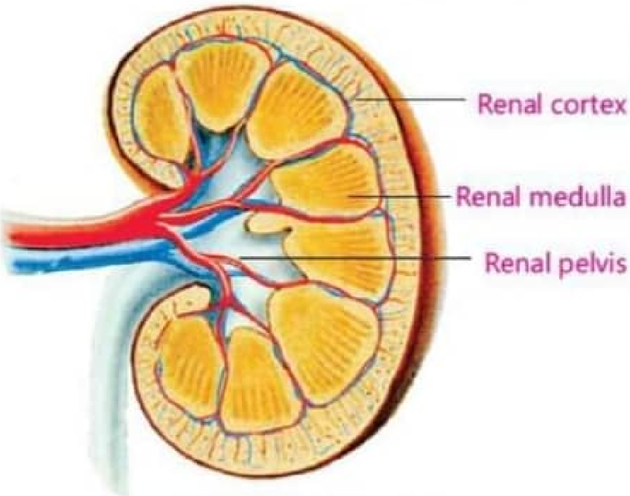
Human excretory system



Structure of a nephron

Internal Structure of Kidney

- Internally, each kidney is divided into three regions, i.e., renal cortex, renal medulla and renal pelvis
- Renal cortex is the outermost region.
- Renal medulla is the middle region which is divided into conical masses called renal pyramids.
- Renal pelvis is the inner area where urine is drained.
- The urine from renal pelvis moves into ureter.



Internal structure of kidney

Nephron

- Nephrons are the functional units of the kidney. They are the tubules where urine is formed.
- There are over one million nephrons in each kidney.
- Each nephron has two parts, i.e., renal corpuscle and renal tubule

Renal Corpuscle

- It is the first part of nephron. It consists of two structures, i.e., glomerulus and Bowman's capsule
- Glomerulus is a tuft of blood capillaries formed by the division and sub-division of small arteries and veins.
- Bowman's capsule is a cup-shaped structure enclosing glomerulus.

Renal Tubule

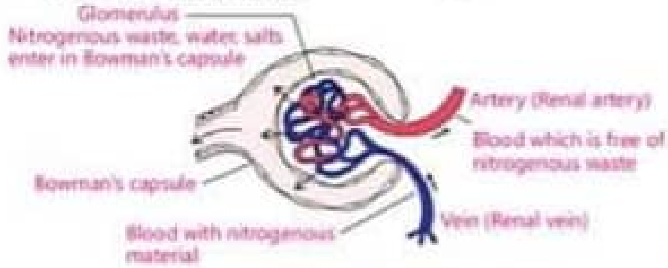
- This part of nephron starts after Bowman's capsule.
- The first coiled part of renal tubule is called proximal tubule.
- The next part is U-shaped and is called Loop of Henle.
- The last part of the renal tubule is again coiled and is called distal tubule.
- The distal tubules of many nephrons open in a collecting duct.
- Many collecting ducts join and drain into renal pelvis.

1.3.2 Function of Kidneys

- Blood carries nitrogenous waste materials from the body to the kidneys. Inside the kidneys, blood containing nitrogenous waste reaches the glomerulus.
- Here, most of the water and waste materials are filtered from the blood into the Bowman's capsule
- The blood after losing waste material is collected in arterioles, which ultimately form renal artery. The "clean" blood is brought back to the main circulatory system.
- This filtrate which moves into the renal tubule of nephron also contains some useful substances.

During its passage towards the collecting duct, 99% of the filtrate (containing useful substances) is reabsorbed into the blood in capillaries around renaltubule.

- During this reabsorption, more waste materials are absorbed from blood capillaries into the renal tubule filtrate.
- Now, the filtrate in renal tubule is called urine which moves into the collecting ducts and then into the renal pelvis.

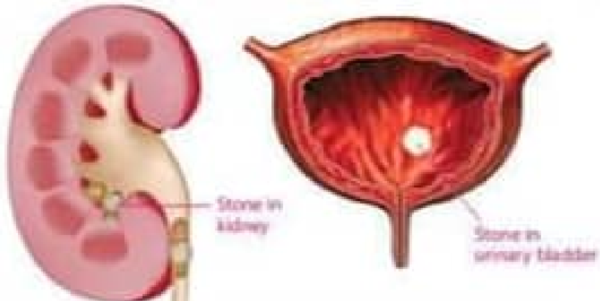


Structure of a Bowman's capsule

1.4 Malfunctioning of Kidneys

1.4.1 Formation of Stones in Kidneys

- Sometimes kidneys cannot work efficiently, i.e. to remove nitrogenous waste or salts from the blood.
- In such situation, the salts accumulate in kidneys and form stones.
- Formation of stones disturbs the normal functioning of kidneys and causes severe pain. Kidney stones may travel to ureter or urinary bladder.
- The common causes of stones in kidneys are excessive calcium salts in the food and uric acid, etc.



Stones in kidney and urinary bladder

- Small sized stones can be removed through urinary system by drinking more water.
- Medium sized stones are removed by lithotripsy.
- Lithotripsy involves bombardment of shockwaves on the stones from outside.
- Shockwaves break the stones into small pieces which are passed out of the body through urine. Still larger stones need surgery for their removal.

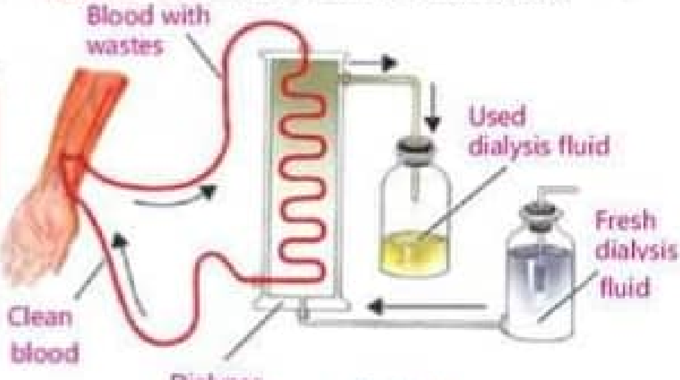
1.4.2 Renal Failure

- Renal failure is the complete or partial failure of kidneys to work.
- The main causes of renal failure are long-term infections, diabetes mellitus and hypertension.
- Diabetes mellitus is a disease in which sugar level increases in the blood.
- Hypertension is a state of high blood pressure in the body. Sudden blockage of blood supply to the kidneys may also result in renal failure.
- Dialysis and kidney transplant are the treatments of renal failure.

1.4.3 Treatment of Malfunctional Kidneys

1.4.3.1 Dialysis

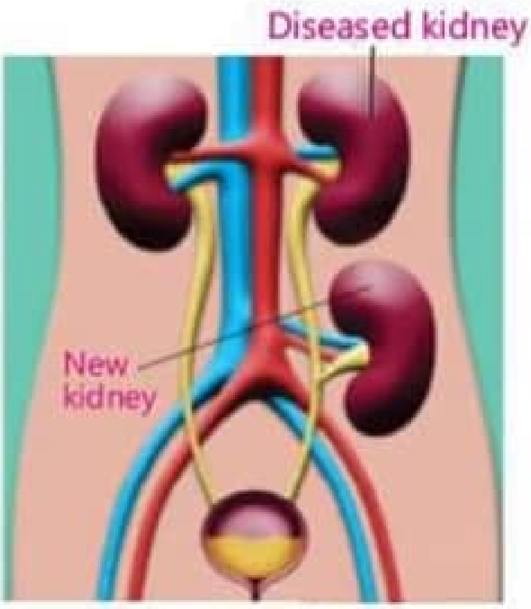
- Cleaning of blood by artificial methods is called dialysis. It is done by a machine called dialyzer. The blood of the patient is passed through the dialyzer which contains dialysis fluid.
- Blood flows through the tubes of the dialyzer and dialysis fluid flows around these tubes
- The waste materials move from blood to the dialysis fluid.
- The cleansed blood is returned to the body.



Dialysis

1.4.3.2 Kidney Transplant

- This method is used at the last stage of kidney failure. In this method, a kidney donated by some healthy person is grafted in the body of the patient
- The donor of kidney may be blood relative or any other close relative.



Kidney transplant

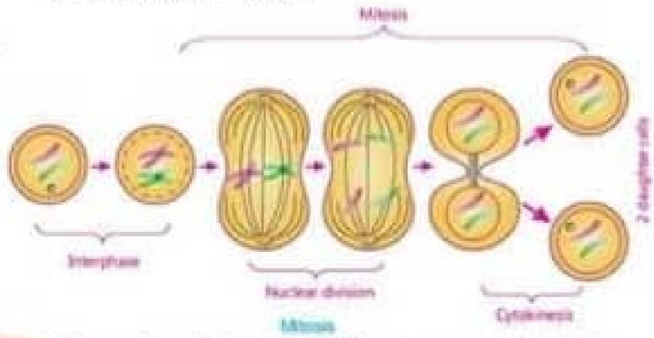
CHAPTER 2. CELL DIVISION

2.1 Cell Division

- Cell division is a process by which a cell divides into two daughter cells. The cell which divides is called **parent cell**.
- The cells which are produced as a result of cell division are called **daughter cells**.
- Before the start of cell division, the parent cell passes through aphase called **interphase**.
- During interphase, chromosomes in the nucleus are duplicated,i.e., copies of all the chromosomes are developed.
- The process of cell division involves two phases, i.e., nuclear division and cytokinesis.
- Nuclear division is the division of nucleus which is followed by cytokinesis.
- Cytokinesis is the division of cytoplasm.
- Nucleus is part of the cell which controls the activities of the whole cell.
- Chromosomes are found in the nucleus of the cell. They consist of proteins and DNA.
- DNA stands for Deoxyribonucleic Acid.
- DNA is the material that contains complete set o instructions for developing a new cell or an organism. That is why DNA is called hereditary material.
- For one kind (species) of organism the number of chromosomes in the cells remain the same.However, when an individual forms gametes(sperms or eggs in animals) or spores (in plants), the number of chromosomes is reduced to half in the gametes or spores.
- Cell division is of two types which are called mitosis and meiosis.

Mitosis

- Mitosis is a process by which the parent cell divides into two daughter cells with same number of chromosomes as in the parent cell.
- The number of chromosomes is doubled during interphase. Two sets of chromosomes are formed.
- During mitosis when the nucleus of parent cell divides the two set of chromosomes are distributed equally in the two daughter nuclei.



- After nuclear division a shallow groove arises in the middle of the cytoplasm which deepens further and divides the cell into two daughter cells, each having a nucleus.

Meiosis

- Meiosis is a process by which the nucleus of a cell divides twice to form four daughter cells in such a way that the number of chromosomes in each daughtercell is reduced to half, compared to the parent cell.
- The process of meiosis consists of two divisions, meiotic-I division and meiotic-II division.
- During meiotic-I division, the number of chromosomes is reduced to half as compared to the parent cell.
- Meiotic-II division is similar to mitosis because the half number of chromosomes is retained in the four daughter cells.

Differences between Mitosis and Meiosis

Mitosis	Meiosis
During mitosis, two daughter cells are formed from the parent cell.	During meiosis, four daughter cells are formed from the parent cell.
The number of chromosomes in the daughter cells remain the same as in the parent cell.	The number of chromosomes in the daughter cells is reduced to half as compared to that in the parent cell.
Mitosis occurs in general body cells	Meiosis occurs to produce gametes (sperms and eggs) in animals or spores in plants.

2.2 Heredity

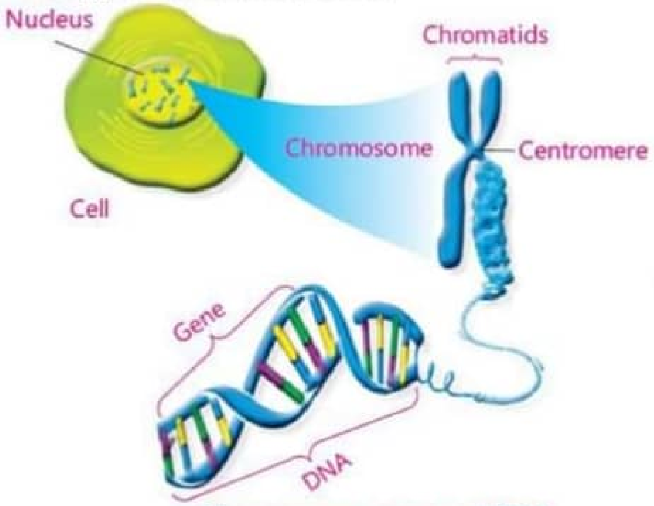
- During reproduction, living things pass on their characteristics to their offspring. This is the reason that babies look like their parents.
- Plants grown from seeds resemble their parent plants.
- The transmission of characteristics from parents to offspring is called heredity.
- The characteristics such as the colour of eyes, skin colour, hair colour, free or attached earlobes, height, intelligence, etc., are the examples of the

characteristics that are transmitted from parents to the offspring and are called **hereditary** characteristics.

- . Differences among members of a family or a species are called **variations**.
- Beneficial variations help organisms to adapt (live successfully) their environment, have greater chances of survival and continue their race.

2.3 Basis of Heredity

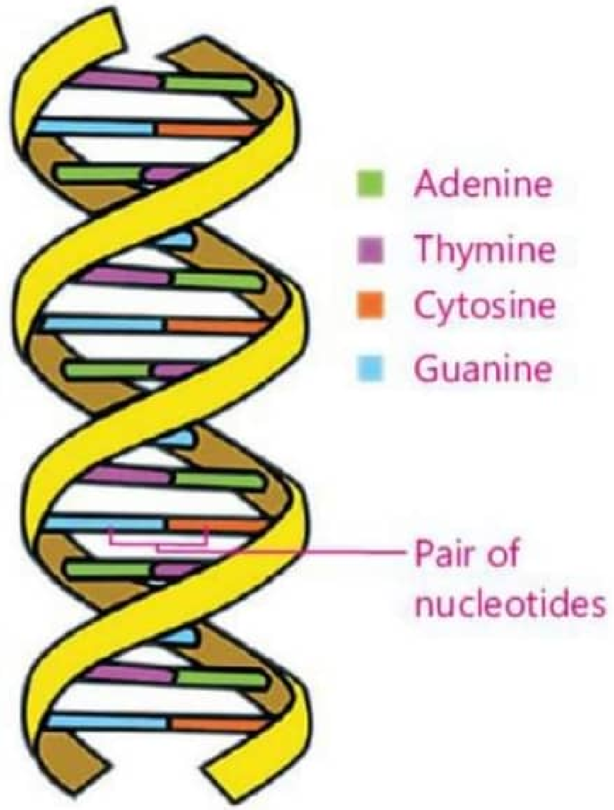
- The basic physical and functional unit of heredity is called gene.
- **Genes** act as instructions to make molecules called proteins.
- Genes occur in pairs.
- Every hereditary character in an organism (e.g., tallness, dwarfness, eye colour, free earlobe, attached earlobe, etc.) is controlled by a pair of genes.
- One member of a gene pair comes from male parent (father) while the other comes from female parent (mother).
- As different sections of DNA (genes) are a set of information for the development of different characters in an organism,DNA is called hereditary material.
- DNA and proteins are the components of chromosomes.
- Chromosomes are thread-like structures found in the nucleus of a cell. They appear as distinct structures only during cell division.
- A typical chromosome consists of two arms called **chromatids** which are attached to the same part called **centromere.**
- The relationship between the cell nucleus, chromosomes, genes and DNA.
- The number of chromosomes is specific and constant for every kind (species) of organism. In general body cells (somatic cells), the chromosomes occur in pairs but the gametes (sperms or eggs) or spores which are formed by meiosis contain one member of each chromosome pair.
- For example; in man, every somatic cell has 46 chromosomes in the form of 23 pairs but every sperm or egg cell has 23 chromosomes.



Chromosomes, genes and DNA

Watson and Crick Model of DNA

- Each DNA molecule is made of thousands of small units called **nucleotides**.
- There are four types of nucleotides in DNA. These are **Adenine (A) nucleotide, Thymine (T) nucleotide, Cytosine (C)nucleotide** and **Guanine (G) nucleotide**.
- According to Watson and Crick, the DNA molecule consists of two strands formed of nucleotides. The two stands of DNA are linked to each other by cross bands like a ladder



Watson and Crick Model

Transmission of Characters

- When an organism forms gametes (sperms or eggs) by meiosis, the number of chromosomes is reduced to half in the gametes, i.e., **haploid (n)** sperms or eggs are produced. It means, the hereditary material (DNA) is also reduced to half in the gametes.
- When male and female organisms mate, the haploid (n) sperm cell from male and haploid (n) egg cell from female fuse with each other to form a **diploid (2n)** cell called **zygote**.
- In this way the complete hereditary material (DNA) is restored in the zygote, i.e., the physical and functional units of all the characters (gene pairs) are transferred in the zygote.
- The zygote after passing through various changes develops into a full organism with specific characteristics from both parents. Thus, zygote is the first cell from which the life of an organism starts.

Inheritable and Non-inheritable Characters

- The characters such as eye colour, skin colour, hair colour, free or attached earlobes, height, intelligence,

etc., are transmitted from parents to the offspring. Such characters that are transmitted from one generation (parents) to the next generation (offspring) are called **inheritable characters**.

- Inheritable characters are controlled by genes.
- Many characters of parents are not transferred to their offspring because these are not developed by genes. Such characters are called **non-inheritable characters**.
- For example, if a body organ of a person is lost or weakened due to disease, this character is not transferred to his or her children.

Examples of Inheritable Characters

i. Eye colour

- The colour of eyes in an organism is controlled by a pair of gene. Thus, it is an inheritable character.
- The genes control the production of brown pigment in the iris of the eyes.
- If the genes work and produce more pigment, the eyes are black. Production of very less pigment results in light brown eyes.
- Blue, green, and hazel eye colours are developed due to the production of brown pigment in different amounts.

Different eye colours

ii. Attached and Detached Earlobes

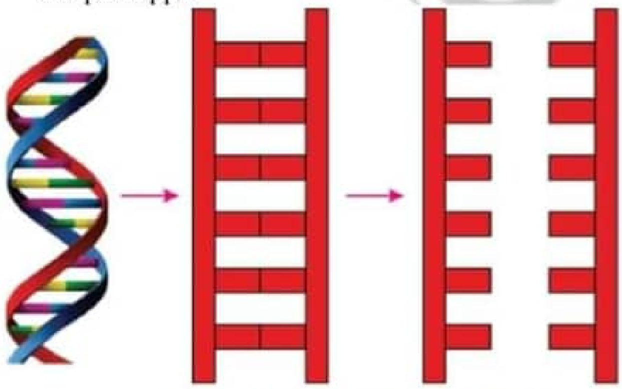
- In some people the earlobes are attached with the sides of the face while others have free earlobes. This character is also controlled by genes.
- When the said genes work, the earlobes hang freely (detached earlobe). Some people do not have this gene. Their earlobes remain attached with the sides of the face.

CHAPTER 3 BIOTECHNOLOGY

- Application of knowledge in the areas like engineering and medicines, etc., is called technology.
- The technology in which living things are used in different ways to help and benefit human beings is called **biotechnology**.
- Microorganisms are used in making bread, yogurt, cheese, vinegar and several medicines.
- Fermentation, tissue culture and genetic engineering, etc., are the processes and techniques in which microorganisms are used for making many industrial products and in the research work. In this chapter, some principles and techniques used in biotechnology will be introduced.
- General applications of biotechnology in the fields of agriculture, environment, health, food production and preservation, etc., will also be discussed.

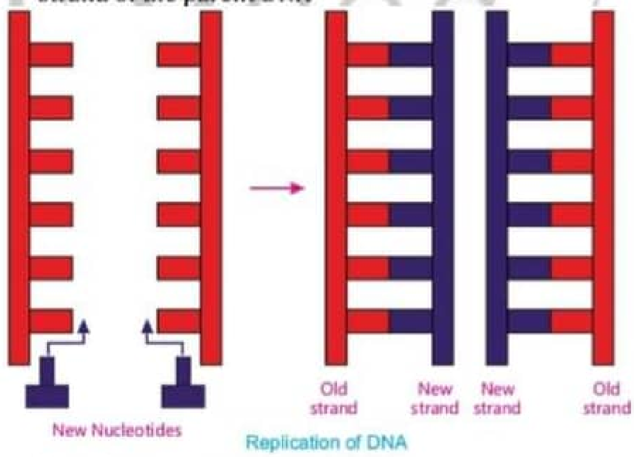
3.1 DNA Replication

- DNA has a unique property to replicate itself. Replication of DNA is a process by which DNA makes its copy. The process of DNA replication takes place in the nucleus of the cell during interphase.
- The first step in DNA replication is unwinding of its double helix structure and separation of two strands from each other like the separation of two strands of an open zipper



Unwinding of DNA and separation of two strands

- In second step, each of these strands produces a new strand using new nucleotides.
- In this way, one double strand DNA molecule produces its identical copy and two daughter DNA molecules are formed.
- Each daughter DNA contains one new strand and one strand of the parent DNA



Replication of DNA

3.2 Introduction of Gene into Bacterium

- Genes act as instructions to make specific substances (proteins) which are used for specific structural and physiological purposes in the body.
- Genetic engineering is an advanced technique in biotechnology in which scientists select and isolate the useful gene from one organism (donor organism) and insert it into another organism usually bacterium.

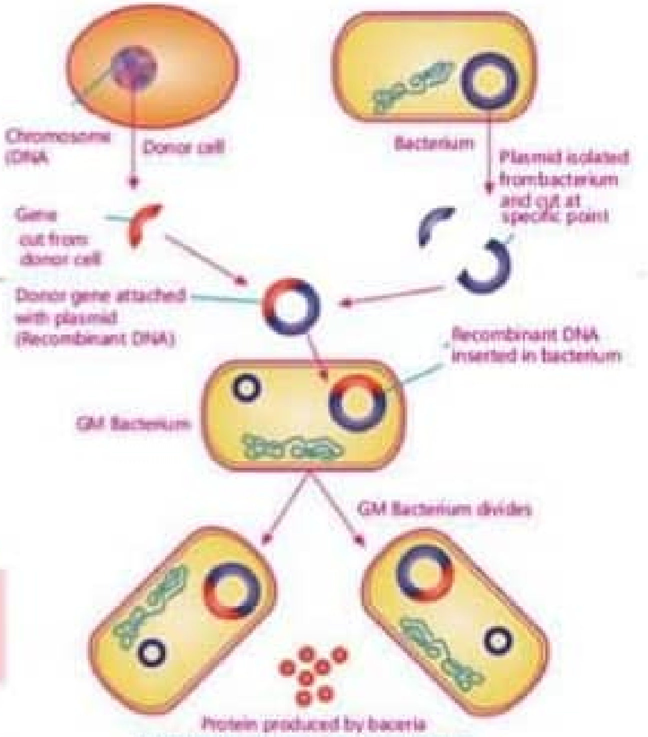
- The organism that contains a foreign gene in its cells is called transgenic organism.
- The inserted gene produces the desired product (protein) in transgenic organism.

Why do Scientists use Bacteria in Genetic Engineering?

- Bacterial cell is very simple and easy to grow. It does not have an organized nucleus.
- The chromosome, consisting of DNA, floats in the cytoplasm.
- Additional circular pieces of DNA called plasmids are also present in the cytoplasm.
- Plasmids can be easily isolated from a bacterial cell and a gene can be attached with it.
- Plasmid can carry the attached foreign gene into the bacterium. In this way, plasmid acts as a carrier of a foreign gene.
- Another reason for using bacteria in genetic engineering is their fast rate of reproduction.

How do Scientists Insert Gene in a Bacterium?

- The first step for inserting a gene into a bacterial cell is the identification and isolation of the gene of desired protein from the donor organism (see Figure 3.4). An enzyme is used to cut the gene from the donor organism.
- The isolated gene is then attached with plasmid DNA taken from a bacterium.
- The same enzyme (used for cutting the donor gene) is used to cut the plasmid DNA at a specific site so that the gene can be attached at the cut end of the plasmid.
- The attached gene of desired protein and the plasmid DNA are collectively called recombinant DNA.
- The recombinant DNA is inserted back into the same type of bacterium from which the plasmid was isolated.
- The bacterium which takes in the recombinant DNA is called genetically modified bacterium (GM bacterium) or transgenic bacterium.



Introduction of gene into a bacterium

- GM bacterium starts dividing and produces a bacterial colony.
- Every bacterium of the colony contains a copy of the gene of desired protein.
- When bacterial colony grows, it starts making proteins under the instructions of inserted gene.
- In genetic engineering, genes of various useful proteins, e.g., insulin, enzymes for the synthesis of various medicines, vaccines, etc., are inserted in bacteria and desired proteins are obtained.

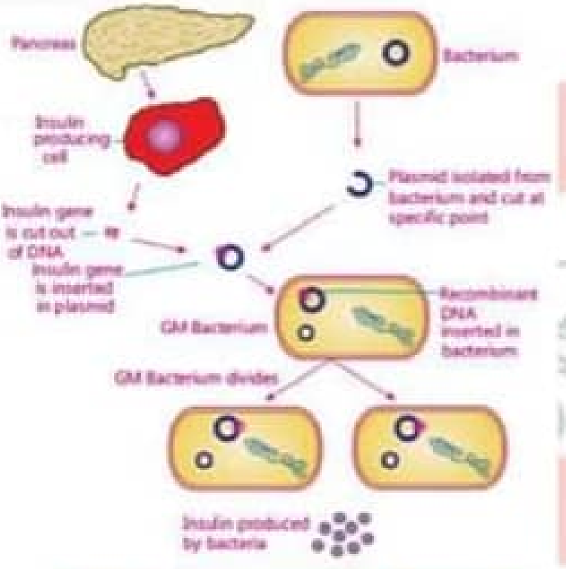
3.3 Genetic Modifications and Biotechnology Products

- The change in the genes of organisms using biotechnology techniques is called genetic modification.
- The change in the genes of an organism can be produced by removal, addition or modification of genes. It is the modern method to change the characters of organisms.
- For example, this process is used in crops to develop resistance in plants against disease-causing microorganisms.
- Similarly, the improvement in the nutritional quality of edible plants is also one of the advancements of genetic modification.
- The organism whose genes are modified is called Genetically Modified Organism (GMO).
- GMOs are also used to prepare useful and lifesaving products such as insulin and vaccines, etc.

Insulin

- Insulin is an animal protein, which is produced by pancreas.
- It controls the glucose level in blood.

- If pancreas does not produce the required amount of insulin, the level of glucose in blood rises. This condition is known as diabetes mellitus in human.
- Diabetic patients need regular injections of insulin to control glucose level in the blood. In past, insulin was extracted from the pancreas of animals.
- Nowadays, it is produced using biotechnology techniques.
- Scientists insert the human insulin gene in bacteria to modify them genetically.
- These genetically modified bacteria (GM bacteria) prepare insulin.
- The insulin prepared in GM bacteria is extracted from bacterial colonies and used.
- The steps of biotechnology techniques for the production of insulin are



Production of insulin by genetically modified bacterium

Vaccines

- Vaccine is a material which contains weakened or killed pathogens (disease causing germs) and is used to produce immunity (resistance) against a disease.
- When a vaccine is injected into the human body, the blood cells in the body take the weak or dead pathogens as real ones and prepare antibodies against them.
- These antibodies remain in blood.
- When any real pathogen enters the body, the already present antibodies kill it immediately and the body becomes protected from disease.
- Nowadays, biotechnologists use bacteria to prepare vaccines. They identify some proteins of pathogens that do not cause disease but can stimulate blood cells to make antibodies. The gene of such protein is inserted into bacterium.
- The GM bacteria make colonies and prepare the pathogen proteins. These proteins act as vaccine.
- When these proteins are injected in human body, its blood cells produce antibodies. These antibodies can kill the kind of the pathogen from which the gene was taken.
- In this way the human becomes safe from that kind of pathogens.
- Vaccines for hepatitis-B, typhoid, measles, etc., have been developed using biotechnology.
- Vaccines for malaria and HIV are being developed.
- Other important lifesaving biotechnology products include blood clotting factors,growth hormones, etc.

3.4 Applications of Biotechnology

- Four major areas in which biotechnology techniques are applied include agriculture, food production and preservation, health and environment.

3.4.1 Agriculture

- Biotechnology has played a revolutionary role in improving our agriculture and production of high yields of crops
- Herbicides (weed killing chemicals) and pesticides (insect killing chemicals) are used to eliminate the crop enemies (weeds and insects). Such chemicals also cause damage to the crop plants.
- Using biotechnology, scientists insert weed resistance and pest resistance genes into the plants. Such genetically modified plants prepare proteins which are harmful for weeds and pest /insects.
- Cultivation of such genetically modified crops improves the quality of the crops and makes them safe for human use.
- The major crops that have been modified are maize (corn), wheat, rice, canola, potato, soybean, cotton, etc.
- Drought and excessive salts in the soil also have harmful effects on crop productivity.
- Biotechnologists are working to find genes that can enable crops to tolerate such extreme conditions

3.4.2 Food Production and Preservation

- Use of better quality genes in the animals is producing high yields of milk and meat
- Production of better quality fruits and vegetables and increasing their shelf lives are also due to using biotechnology techniques

3.4.3 Health

- Biotechnology techniques are also used for curing diseases and improving health.
- The diseases for which previously no adequate treatment was available can now be treated using biotechnology techniques.
- Identification of root causes of diseases, production of medicines for fighting against diseases and curing and correction of genetic defects, etc.,are the major roles of this technology in developing better health.
- Various biotechnology products which are used to save lives include:
- **Insulin:** useful for diabetics
- **Vaccines:** used against many infectious diseases
- **Growth hormone:** useful for stimulating growth
- **Beta-Endorphin:** a pain killer drug
- **Interferon:** anti-viral proteins

Important biotechnology techniques

Gene Therapy

- Gene therapy is an advanced biotechnological technique which is used to cure genetic and acquired diseases like cancer and AIDS.
- In this process, defective genes are supplemented or replaced by normal genes.

Genetic Testing

- Genetic testing is one of the latest biotechnological techniques used for genetic diagnosis of inherited diseases.
- It involves the direct examination of DNA molecule. It is also used to determine a child's paternity or a person's ancestry.

Cloning

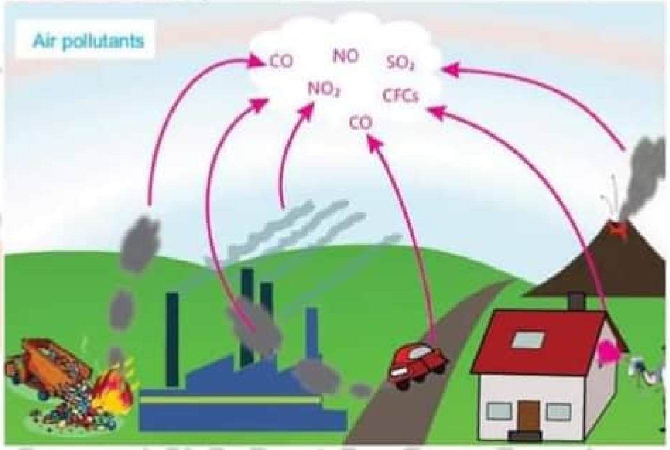
- Cloning is also amongst the latest biotechnological techniques used in various types of genetic analyses.
- Animal cloning can be used for production of animal organs, and strong, well built livestock for quality production of milk and meat.
- **3.4.4 Environment**
- Environmental problems, like pollution, degradation of land and sewage water, etc., are also resolved using biotechnology.
- Microorganisms, e.g., genetically modified bacteria are used to treat sewage and refuse.
- They may also be used to clear spilled oil. Microbes which are used as bio-pesticides, bio-fertilizers, biosensors, etc., are being developed using biotechnology techniques.

CHAPTER 4 POLLUTANTS AND THEIR EFFECTS ON ENVIRONMENT

- The environment we live in is not as clean as it should be. Various natural and human activities contaminate it with harmful substances.
- Dust storms, rotting of vegetation, volcanic eruption, etc., are the natural phenomena which release dust particles and poisonous gases in the environment.
- On the other hand, burning of fuels in the vehicles and industry and many other human activities are releasing poisonous compounds in the environment.
- The poisonous and harmful substances which contaminate or pollute the air are called **air pollutants**.

4.1 Air Pollutants and Their Sources

- Carbon monoxide (CO), sulphur dioxide (SO_2), oxides of nitrogen (NO and N_2O_2), chlorofluorocarbons (CFCs), etc., are the main air pollutants. Poisonous gases produced during the decay of dead organic matter and particulate matter like soot, dust particles, pollens, metallic compounds (e.g., compounds of lead), etc., also pollute the air.
- Carbon monoxide is produced by the incomplete combustion of coal and other fossil fuels (natural gas, petrol, oil, etc.).
- Smoke released from motor vehicles and industries is the main source of carbon monoxide.
- Sulphur dioxide is produced by burning of coal or oil in factories.
- Smoke released from thermal power stations usually contains sulphur dioxide.
- Oxides of nitrogen are produced by burning of coal and oil at high temperature in industries and vehicle engines.
- Chlorofluorocarbons (CFCs) are the compounds which contain chlorine, fluorine and carbon atoms.
- CFCs are used in aerosol sprays, refrigerators and air conditioning system. On leakages from these appliances, CFCs enter the air.
- Fossil fuels (coal, natural gas, oil, petrol, etc.) and aerosols are the main **sources of air pollutants**.
- Rotting vegetation and volcanic eruption are natural sources of air pollution



4.1.1 Properties of Air Pollutants Their and Effects on Human Organ Systems

Carbon monoxide

- Carbon monoxide is a colourless, odourless and poisonous gas.
- It affects the human organ systems badly and causes headache, brain damage and respiratory problems.
- When carbon monoxide reaches our blood, it binds with haemoglobin and reduces its oxygen-carrying capacity.

Sulphur dioxide

- It is a colourless gas with irritating smell.
- It dissolves in rain water and causes acid rain.
- Exposure to sulphur dioxide causes breathing difficulties, pneumonia, lung cancer etc.

Oxides of Nitrogen

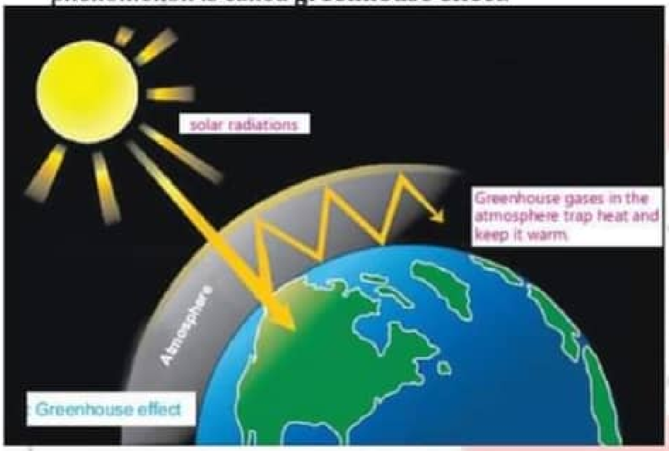
- Oxides of nitrogen are all toxic gases.
- They dissolve in rain water to cause acid rain.
- They have severe effects on lungs and damage them

4.2 Effects of Human Activities on Environment

- Human activities such as burning of fuels, extensive use of vehicles, aerosols, fertilizers,insecticides, pesticides, etc., and deforestation are affecting the environment badly..

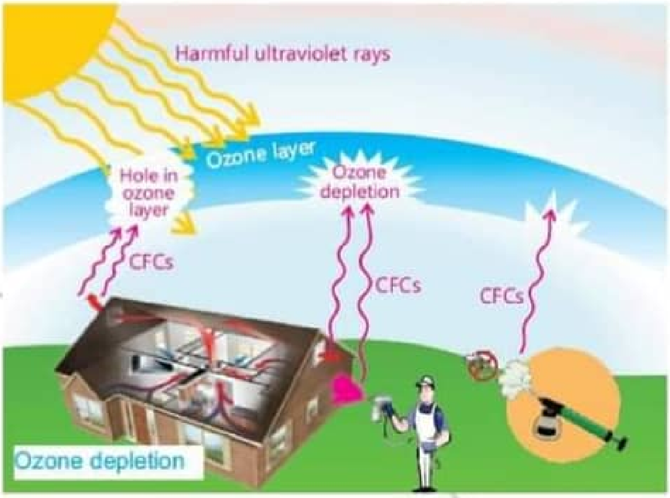
4.2.1 Greenhouse Effect

- When sunlight falls on the Earth, a small part of it is absorbed by the Earth and is converted to heat energy. A part of this heat energy is reflected by the Earth back to the atmosphere.
- Some gases present in the atmosphere, e.g., carbon dioxide, methane, oxides of nitrogen, water vapours, etc., trap a part of the heat reflected by the Earth causing increase in the atmospheric temperature, These gases are called **greenhouse gases** and the phenomenon is called **greenhouse effect**.



4.2.2 Ozone Depletion

- A layer of ozone (O_3) in the upper atmosphere of the Earth stops the ultraviolet rays coming from the Sun to the Earth.
- In this way, the living things on the Earth remain safe from harmful effects of the ultraviolet radiation coming from the Sun.
- Chlorofluorocarbons (CFCs) which are used in air conditioners, refrigerators, spray cans, etc., enter the air on leakage from these appliances.
- On reaching the ozone layer, they react with ozone and cause thinning of this layer. Hence, the ozone layer is depleted. The phenomenon is called **ozone depletion**.
- Through the thin ozone layer, ultraviolet rays of the Sun pass and reach the Earth where they affect the life by causing serious diseases like skin cancer and eye problems, etc.
- These ultraviolet rays also increase the temperature of the Earth.

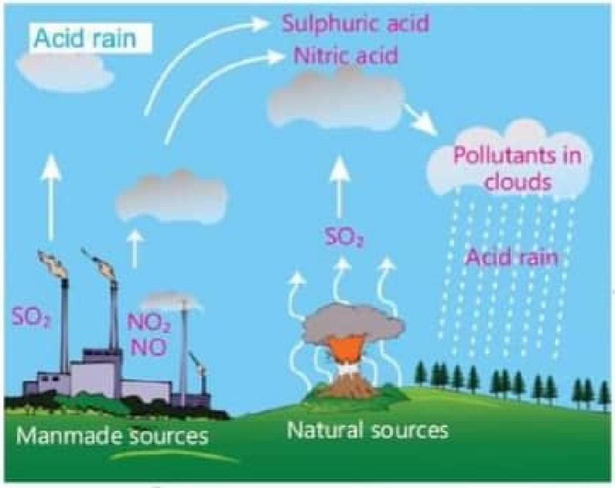


4.2.3 Global Warming

- Due to human activities like burning of fuel, etc., the amount of greenhouse gases is increased in the atmosphere. This speeds up the greenhouse effect.
- The increasing rate of greenhouse effect and ozone depletion is increasing the average temperature of the Earth. As a result, the Earth globe is getting warmer. This is called **global warming**.
- Due to global warming, the ice in the Polar Regions and at the mountains melts at a greater rate.
- This leads to rise in the level of sea water which creates floods in low lying coastal areas.
- The climate of many regions of the world is also changing due to global warming.
- The global warming is thus a threat to the life on the Earth

4.2.4 Acid Rain

- Sulphur dioxide and oxides of nitrogen are present in the atmosphere as air pollutants.
- They get dissolved in water vapours in clouds and turn into acids like sulphuric acid and nitric acid.
- These acids make the rain water acidic.The effects of acid rain on animals, plants and buildings.
- Acid rain kills the aquatic life in rivers, lakes and ponds etc.
- It destroys the leaves and barks of the trees.
- It corrodes the metals and the stones used in buildings.
- The acid rain water flowing into fields makes the soil acidic.
- The crops do not grow well in acidic soil.
- Microorganisms present in soil are also affected by acid rain.



4.2.5 Deforestation

- Forests are our great wealth.
- They bring favourable changes in climate of an area.
- They stop storms and bring rains.
- They are source of many useful materials such as timber, firewood, resins, gums and medicines, etc.
- They prevent soil erosion.
- They provide habitat to a wide variety of wild life.
- Unfortunately, forests are cut to meet the demand for timber and to obtain land for housing and agriculture. As a result, the ecosystem is destroyed.
- Destruction of forests as a result of human activities is called **deforestation**

Effects of Deforestation on the Environment

- Deforestation has many adverse effects on the environment.
- It changes weather and climate. Roots of trees hold the soil.
- Cutting of trees leads to soil erosion and fertile part of the soil is lost through this process. When forests are cut, rate of evaporation is reduced which results in less rain.
- Deforestation decreases the carbon dioxide consumption by plants increasing its amount in the environment.
- This leads to the increased greenhouse. effect and global warming.

Effects of Deforestation on Wildlife

- All non-cultivated plants and non-domesticated animals of an area are collectively called wildlife.
- Deforestation destroys the habitats of wildlife.
- The extinction risk of wildlife is increased while the natural balance maintained by the wildlife is disturbed.

4.2.6 Lack of Natural Resources

- Resources are the materials in the environment that are ready for human use or may be used in future.
- Fossil fuels (coal, natural gas, oil, etc.), minerals, trees, animals, water, etc. are all natural resources.
- The resources on the Earth are limited. Many of them, e.g.,minerals and fossil fuels are non-renewable. A resource that does not regenerate quickly is called **non-renewable resource**.
- The limited and non-renewable resources (fossil fuels, etc.) are used to produce energy for running industry, transport and household appliances.
- They will get depleted and hence alternate sources of energy need to be developed. A lot of energy which could do useful work is wasted by man.
- For instance, household appliances are left running even when no one is using them. Similarly, instead of using public transport personal cars are used which consume a lot of fuel.
- The unwise use of non-renewable resources of energy may result into non-recoverable loss.
- To avoid such loss, the resources must be conserved for future use. We must also search for alternate sources of energy like solar energy, wind energy, hydropower and atomic energy, etc.

4.3 Conservation of Resources

- Fossil fuels are present on the Earth in limited quantities. Their unwise use must be stopped and they need to be conserved.
- Three (3) R strategies, i.e., **Reduce-Reuse-Recycle** can be adopted for conservation of resources
- The first strategy in this connection is **"Reduce"**, i.e.,the use of non-biodegradable objects should bereduced and the resources which are used in their manufacture should be conserved.
- The second step in three (3) R strategies is **"Reuse"**, i.e., the non-biodegradable objects should be used again and again instead of throwing them after first use.
- The third strategy is **"Recycling"**, i.e., the waste objects made of nonbiodegradable materials should be collected, cleaned, melted and remolded into new objects.
- By adopting the above said (3R strategies) habits, we can conserve our resources.

4.4 Saving the Earth

- The Earth is the only planet in our Solar System where life can survive. Pollutants are harmful to the life on Earth.
- We should keep the Earth's environment clean and healthy.

- Following measures can be taken for saving the Earth from the toxic effects of pollutants.

4.4.1 Solid Waste Management

- Solid wastes include plastic and glass items, styrofoam, sewage sludge, agricultural wastes, and domestic trash, etc.
- These wastes pollute the Earth's environment when dumped on open places or burnt
- Hence, we should not dump them on open places nor burn them.
- They should be managed properly. Landfill, incineration and recycling are the common methods of solid waste management.

Landfill

- In this method, solid wastes are buried in properly designed landfills which are well managed for maintaining hygienic conditions.
- It is relatively inexpensive method of disposing of waste materials.

Incineration

- In this method, wastes are burned at extremely high temperatures.
- In this method, plastic items (like plastic bottles and polythene bags), glass pieces, aluminium and steel cans, copper wires, etc. are collected separately, cleaned, meltedand moulded into new products.
- In this way, they are used again and again to reduce pollution.

4.4.2 Environmental campaigns

- Environmental campaigns should be conducted frequently for creating awareness among common people about pollution and reducing its harmful effects.
- Such campaigns may include seminars, school talks / debates, celebrating the World Environment Day (5th of June every year), etc.

4.3.3 Responsibility for All

Following measures can be taken to reduce air pollution.

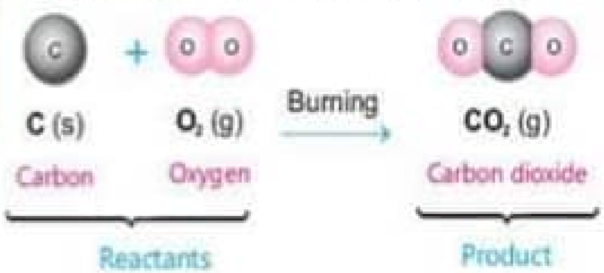
- Domestic trash and other solid wastes should not be dumped on open places.
- Instead of personal car, public transport should be used for travel.
- Sulphur and lead free fuel should be used in vehicles.
- Factories and industries should be shifted away from the urban areas.
- Acidic industrial exhaust gases must be neutralized before releasing into the air.
- Engines of the vehicles should be tuned properly.
- CFC-free products should be used.
- 3R strategies of Reduce-Reuse-Recycle for the conservation of resources should be adopted.
- Trees should be grown along the road sides.
- Deforestation should be avoided.

CHAPTER 5 CHEMICAL REACTIONS

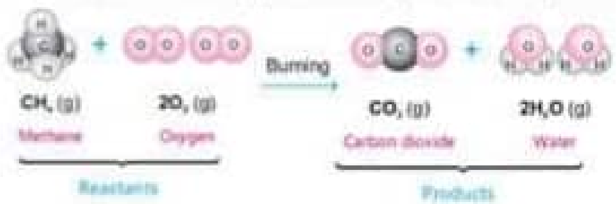
- Liquid water, ice and steam are the three physically different forms of the same substance, i.e., water (H_2O).
- A change in a substance during which entirely new substances with different chemical compositions and properties are formed is called a chemical change.
- A chemical change is always brought about by a chemical reaction.

Chemical Reactions

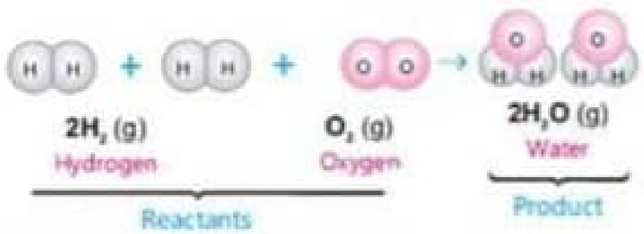
- During reactions, atoms present in different substances rearrange themselves form new substances.
- Burning of coal and natural gas (methane) in air are well known examples of chemical reactions.



- Substances which take part in a chemical reaction are called **reactants** and those which are formed as a result of the reaction are called **products**.
- When methane burns in air, carbon dioxide and water are formed. During the rearrangement of atoms in burning of methane (natural gas), carbon atom of methane gets attached with two oxygen atoms to give carbon dioxide while hydrogen atoms attach themselves with oxygen atom to give water vapours.



- The rearrangement of atoms during the chemical reaction of hydrogen with oxygen to form liquid water.



Applications of Chemical Reactions

- During photosynthesis in plants, carbon dioxide (CO_2) and water (H_2O) react to produce glucose ($C_6H_{12}O_6$). This reaction takes place in the presence of sunlight and green pigment chlorophyll.

$$6CO_{2(g)} + 6H_2O \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_{6(aq)} + 6O_{2(g)}$$

Carbon dioxide Water Glucose Oxygen

- During respiration, the oxygen of air reacts with food (glucose) to produce, carbon dioxide and water in the cells of living organisms. The energy produced during this reaction is used to perform all the body functions in living organisms.

$$C_6H_{12}O_{6(s)} + 6O_{2(g)} \rightarrow 6CO_{2(g)} + 6H_2O + \text{Energy}$$

Glucose Oxygen Carbon dioxide Water

- Conversion of milk into yogurt and formation of baking products involve the chemical changes which are brought about by microorganisms. Such chemical changes or reactions are called fermentation reactions.

Chemical Equations and their Balancing

- A chemical equation is the representation of a chemical reaction in terms of symbols, formulae and signs, etc.
- In a chemical equation the reactants and products are separated by an arrow.
- Symbols and formulae of the reactants are written on the left hand side of the arrow whereas the products are written on the right hand side of the arrow. The arrow is directed towards the products.
- Physical states of reactants and products are also expressed along with their formulae or symbols by (s), (g) and (aq) which stand for solid, gas and aqueous states respectively.
- For example; the chemical equation representing the reaction of sulphur with oxygen to from sulphur dioxide is written as follows.

$$S\,(s) + O_2\,(g) \rightarrow SO_2\,(g)$$

- $S\,(s) + O_2\,(g) \rightarrow SO_2\,(g)$

The chemical equation written above shows that sulphur in its solid state reacts with oxygen gas. The product of the reaction, i.e., sulphur dioxide is also a gas. The signs (s) and (g) indicate the physical states of the reactants and the products.

- the chemical equation given below indicates that zinc in its solid state reacts with aqueous solution of sulphuric acid and produces aqueous solution of zinc sulphate and hydrogen gas.

$$Zn\,(s) + H_2SO_4\,(aq) \rightarrow ZnSO_4\,(aq) + H_2\,(g)$$

Zinc + Sulphuric acid → Zinc sulphate + Hydrogen

Balancing the Chemical Equation

- The chemical equation in which the number of atoms of each element on both sides of the equation, i.e., reactant side and product side are equal is called a balanced chemical equation.
- For example, the chemical equation shown below is a balanced chemical equation.

Hcl (aq) + NaOH (aq) → NaCl (aq) + H2O

- The chemical equation in which the number of atoms of each element on both sides of the equation, i.e., reactant side and product side is not equal is called an unbalanced chemical equation.
- For example, the chemical equation given below is an unbalanced chemical equation.

$H_2\,(g) + Cl_2\,(g) \rightarrow HCl\,(g)$

- Unbalanced equations can be balanced by different methods. The trial and error method is commonly used.
- According to this method, trial and error process of adjusting coefficients before symbols or formulae is continued till the number of atoms of each element on both sides of the equation becomes equal.
- The working rules for balancing a chemical equation are as follows:
  - Write the unbalanced equation and count the number of atoms of each element on both sides of the arrow.
  - Work with one element at a time.
  - Multiply the symbol or formula with suitable integers (2, 3, 4, 5, etc.) on that side of the equation where the number of atoms of a particular element is less and try to balance this element on both sides of the equation. Start multiplying with relatively small numbers.
  - Repeat the process for all the elements one by one.
  - Balance the diatomic molecules like H, N, O, Cl, etc. at the end. 2 2 2 2 Some examples for balancing the equation are given below.

Law of Conservation of Mass (Matter)

- Law of conservation of mass was put forward by a French Chemist Lavoisier in 1785.
- This law states that during a chemical reaction, mass is neither created nor destroyed but it changes from one form to another.
- In other words during a chemical reaction, total mass of the products is equal to the total mass of the reactants.
- the formation of white precipitate of silver chloride (AgCl) as a product of the reaction between sodium chloride (NaCl) and silver nitrate (AgNO) solutions. The balanced chemical equation for the reaction is as follows:

AgNO3 (aq) + NaCl (aq) → AgCl (s) + NaNO3 (aq)

5.4 Types of Chemical Reactions

Addition Reactions

- The chemical combination of two or more substances to form one compound is called addition reaction.

Decomposition Reactions

- A chemical reaction during which a compound splits up into two or more simple substances is called a decomposition reaction.
- Usually heat is required to bring about decomposition of compounds.

Energy Changes in Chemical Reactions

- The energy of a substance is a particular amount of energy due to which the structure of the substance remains stable.
- A substance undergoes a chemical change or chemical reaction when its energy is changed.
- The change in energy of a substance takes place by absorbing or releasing heat or light.
- On the basis of the change in energy, chemical reactions can be classified into two types, i.e., exothermic and endothermic reactions.

Exothermic Reactions

- Exo means outside and therm means heat.
- Exothermic reactions are those reactions during which heat is given out. Burning is a common example of exothermic reaction.
- Fossil fuel (coal, natural gas, etc.) burns in the air to release heat.

$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} + \text{Heat}$

$CH_{4(g)} + 2O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O + \text{Heat}$

$Fe_{(s)} + S_{(s)} \rightarrow FeS_{(s)} + \text{Heat}$

5.5.2 Endothermic Reactions

- Endo means inside.
- The reactions during which heat is absorbed are called endothermic reactions.
- Thermal decomposition of calcium carbonate to produce carbon dioxide on commercial scale is an endothermic reaction.
- $CaCO_3 + \text{Heat} \rightarrow CAO + CO_2$
- $CaCl_2 + Na_2CO_3 + \text{heat} \rightarrow CaCO_3 + 2NaCl$
- Formation of nitric oxide from nitrogen and oxygen and hydrogen iodide from hydrogen and iodine are also the examples of endothermic reactions.
- $N_2 + 2O_2 + \text{heat} \rightarrow 2NO_2$
- $H_2 + I_2 + \text{heat} \rightarrow 2HI$

CHAPTER 6 ACIDS, BASES/ALKALIS AND SALTS

Acids

- The word acid is derived from Latin word 'acidus' means sour.
- In chemistry, the term acid has been used to name a group of compounds that have sour taste.
- Acids can be defined as the compounds which produce hydrogen ions (H+) in their aqueous solutions.
- Citrus fruits have sour taste due to citric acid.
- Hydrochloric acid is an important mineral acid.
- It is also found in gastric juice of the stomach.
- It acts as an antiseptic and is helpful in digestion of proteins.

Sources of Common Acids

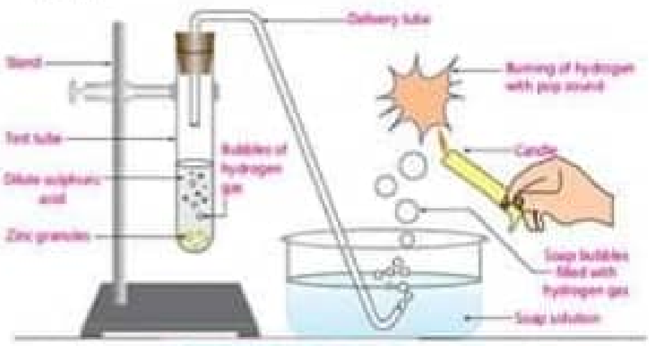
- Generally, acids are obtained from two different sources. Some acids occur in plants and animals and are known as organic acids while others are obtained from minerals and are called mineral acids.

Some important acids obtained from animals or plants	
Name	**source**
Formic acid	Ant's sting
Acetic acid	Vinegar
Oxalic acid	Tomatoes
Citric acid	Citrus fruit
Tartaric acid	Tamarind, grapes
Lactic acid	Yoghurt
Malic acid	Apples
Stearic acid	Fats

Mineral acid	Formula
Hydrochloric acid	HCl
Nitric acid	HNO3
Phosphoric acid	H_3PO_4
Sulphuric acid	H_2SO_4

Properties of Acids

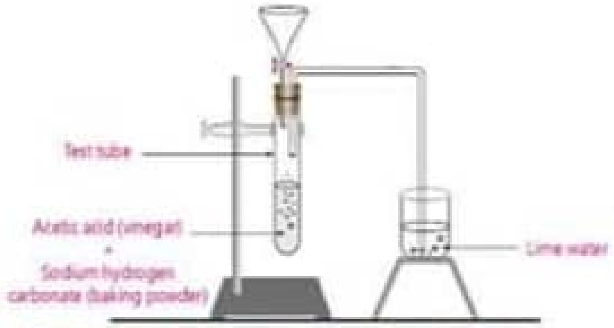
- All acids have a sour taste.
- All acids turn blue litmus solution and methyl orange solution red.
- Strong acids are corrosive liquids. They burn skin and destroy fabrics and animal tissues.
- Aqueous solutions of acids are good conductors of electricity.
- Acids react with reactive metals (Mg, Zn) to form salt and evolve hydrogen gas
- $Mg + 2HCl \rightarrow MgCl_2 + H_2$
- $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$
- Hydrogen gas produced in the reaction burns with pop sound



Reaction of zinc with dilute acid

- Acids react with metal carbonates and metal hydrogen carbonates to liberate carbon dioxide.

- $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$
- $NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + H_2O + CO_2$



Reaction of acetic acid with sodium hydrogen carbonate

Uses of Acids

Hydrochloric Acid

- Hydrochloric acid is used for cleaning rust from the surface of metals.
- Hydrochloric acid is used for purification of common salt (NaCl).
- Hydrochloric acid is used to make Aqua Regia (3HCl + HNO) used to dissolve noble metals such as gold. 3
- Hydrochloric acid is used for making glucose from starch.
- Hydrochloric acid is used for the proper digestion of food in our stomach.

Nitric Acid

- Nitric acid is used in the manufacture of fertilizers like ammonium nitrate.
- Nitric acid is used for the manufacture of explosives.
- Nitric acid is used in the manufacture of dyes, plastics and artificial silk.
- Nitric acid is used for etching designs on metals like copper, brass and bronze.

Sulphuric Acid

- Sulphuric acid is used as a dehydrating agent.
- Sulphuric acid is used in the manufacture of fertilizers like ammonium phosphate, calcium ammonium phosphate, calcium super phosphate, etc.
- Sulphuric acid is used in the manufacture of celluloid plastic, artificial silk, paints, drugs and detergents.
- Sulphuric acid is used in petroleum refining, textile, paper, and leather industries.
- Sulphuric acid is used in lead storage batteries. The uses of sulphuric acid are so large and so important that it is known as the king of chemical.

Acetic Acid

- Acetic acid is used in the preparation of pickles.
- Acetic acid is used in the manufacture of synthetic fibre.

6.2 Bases / Alkalis

- Many compounds have properties which are contrary to acids. Such compounds are termed as bases.
- The bases which are soluble in water are called alkalis.
- The word alkali has been taken form Arabic word "qali" which means "from ashes".
- Alkalis are obtained from the ashes of plants.
- Alkalis/bases are the compounds which produce hydroxide ions (OH^-) in their aqueous solutions. Sodium hydroxide (NaOH), potassium hydroxide (KOH), calcium hydroxide $Ca(OH)_2$, etc., are the examples of bases / alkalis.

Some common alkalis and their formulae	
Alkali	**Formula**
Sodium hydroxide	$NaOH$
Potassium Hydroxide	KOH
Calcium hydroxide	$Ca(OH)_2$
Ammonium hydroxide	NH_4OH
Magnesium hydroxide	$Mg(OH)_2$

Properties of Bases / Alkalis

- Aqueous solution of a base has a soapy touch.
- Bases turn red litmus blue, colourless phenolphthalein pink and methyl orange yellow. They turn turmeric paper brown.
- Aqueous solution of bases are good conductor of electricity.
- Bases react with acids to form salts and water. The reaction is called neutralization reaction.
- Alkalis when heated with ammonium salts produce ammonia gas We can identify ammonia gas by its pungent smell. Ammonia also turns moist red litmus paper blue.
- Alkalis react with fats to form soap.

Uses of Bases / Alkalis

Sodium hydroxide (NaOH)

- Sodium hydroxide is largely used in:
- Sodium hydroxide is largely used in soap, textile and plastic industries.
- Sodium hydroxide is largely used in petroleum refining.
- Sodium hydroxide is largely used in making rayon.
- Sodium hydroxide is largely used in the manufacture of paper pulp and medicines.

Calcium hydroxide

- Calcium hydroxide is used in the manufacture of bleaching powder.
- Calcium hydroxide is used as a dressing material for acid burns.
- Calcium hydroxide is used in in making lime sulphur sprays to be used as fungicide.
- Calcium hydroxide is used as a water softener.
- Calcium hydroxide is used for neutralizing acidity present in soil.

Ammonium hydroxide

- Ammonium hydroxide is used to remove grease from window panes.
- Ammonium hydroxide is used to remove ink spots from clothes.

- Ammonium hydroxide is used as a reagent in laboratory.
- Ammonium hydroxide is used for the treatment of bees' stings.

6.3 Salts

- A salt is a compound formed by the neutralization of an acid with a base.
- A large variety of compounds exists as salts.
- Sodium chloride is a common salt which we use in our food.

Salt	Formula
Sodium chloride	$NaCl$
Potassium chloride	KCl
Ammonium chloride	NH_4Cl
Calcium chloride	$CaCl_2$
Sodium carbonate	Na_2CO_3
Sodium hydrogen carbonate	$NaHCO_3$
Sodium carbonate	$NaNO_3$
Potassium nitrate	KNO_3
Ammonium nitrate	NH_4NO_3
Calcium sulphate	$CaSO_4$
Calcium carbonate	$CaCO_3$
Copper sulphate	$CuCO_4$

Properties of Salts

- Salts exist in solid states. They are found in crystalline or in powder forms.
- Salts have high melting and boiling points.
- Generally, salts are soluble in water. However, the salts like calcium carbonate, lead chloride and cadmium sulphate, etc., are insoluble in water.
- Aqueous solutions of metal salts or their molten forms conduct electricity.
- Many of the salts contain water molecules in their crystals which are responsible for the shape of the crystals.
- Carbonates and bicarbonates react with acids to liberate carbon dioxide gas.
- When salts of heavy metals react with alkalis, precipitates of heavy metal hydroxides are formed in the reaction mixture. Precipitates are the substances which appear as solid insoluble product in the liquid reaction mixture.
- The chemical reaction of water with a salt produces an acid and a base and the reaction is called hydrolysis.

Uses of Salts

Role of salts in human body

- Salts of sodium, potassium, calcium, magnesium and iron are needed for the normal working of our body.
- Sodium and potassium salts are needed for the proper functioning of muscles and the nervous system.
- Salts of calcium are present in bones. They are responsible for the strength of bones.
- These salts are responsible for preventing heart attacks.
- Potash alum is used to coagulate the blood coming out of a wound. It is also used for the purification of water.
- Salts of iodine are needed for the proper functioning of thyroid glands. They are also used for the treatment of goiter.

Uses of salts in our daily life

- In our daily life, we use common salt for seasoning food. It is also used as a preservative for fish and pickles.
- Baking soda is used for giving softness to bread and cake.
- Washing soda is used for washing clothes.
- Sodium potassium tartrate is used as a laxative.

Uses of salts in industries

- Sodium chloride is used for the manufacture of chlorine, hydrogen chloride, caustic soda, washing soda and sodium hydrogen carbonate.
- Sodium carbonate is used for softening hard water and for the manufacture of glass and soap.
- Potassium nitrate is used for the preparation of gun powder and fireworks. It is also used as a fertilizer.
- Potash alum is used for purification of water, in dyeing cloth and for tanning hides.
- Copper sulphate is used as a fungicide, in calico printing and in electroplating.

6.4 pH scale

- The scale which is used to measure the strength of acidic or alkaline solution is known as pH scale.
- The pH of a solution can be found with the help of universal indicator or pH paper.
- A universal indicator paper has a mixture of several dyes coated on it. It shows different colours for different pH values of the solutions.
- In an acidic solution, colour changes from yellow to orange and then red as the pH decreases. The colour changes from indigo to violet when pH changes from 7 to 14.
- You will observe that different shades of colour appear on each strip of pH paper. By comparing the colours with the chart provided with the pH paper you can find the pH of different solutions.
- Strong acids have pH value 0 to 2. pH of weak acids is in between 3 and 6. pH of strong alkalis is 12 to 14.

pH and its Range (0 –14) in Aqueous Medium

- Pure water ionizes very slightly into hydrogen (H^+) and hydroxide (OH^-) ions.
- However, the concentrations of hydrogen ions (H^+) and hydroxide ions (OH^-) in pure water are equal.
- Hydrogen ion concentration increases, when acids are dissolved in water. Alkalis on dissolving in water decrease the concentration of hydrogen ions in water as compared to hydroxide ion.
- The greater the concentration of hydrogen ions (H^+) in a solution, the stronger the acid it is.
- The lesser the concentration of hydrogen ions as compared to hydroxide ions in a solution, the stronger the alkali it is. Hence, the scale which is used to measure the strength of an acid or alkali in an aqueous solution is based on the concentration of hydrogen ions (H^+) which is termed as pH.

- pH values range from 0 – 14.
- The solutions having equal concentrations of hydrogen ions (H+) and hydroxide ions (OH–) are neutral solutions. They have pH = 7. pH = 7 is the midpoint of the pH scale.
- The solutions with higher concentration of hydrogen ions will have lower than 7 value of pH.
- The solutions with lower concentration of hydrogen ions than that of hydroxide ions will have greater than 7 value of pH.
- Solution with lower pH values are stronger acids.
- The solutions with higher pH values are stronger alkalis.
- The higher the pH value of the solutions, the stronger the alkalis they are.

pH Meter

- The instrument which is used to measure the exact pH of the solutions is called pH meter
- When the electrode of pH meter is dipped in the solution, the reading of its pH appears on the digital display of pH meter.

Indicators

- Majority of acids and bases are colourless.
- It is not possible to identify them by their appearance. In order to identify whether a substance is an acid or alkali indicators are used.
- An indicator is a substance that shows different colours in acidic and basic solutions.
- Some examples of indicators are phenolphthalein, methyl orange, litmus, turmeric, china rose and red cabbage.

Indicators and their colours in acidic and basic solutions			
Indicator	Original colour	Colour in acid	Colour in base
Litmus	Voilet	Red	Blue
Phenolphthalein	Colourless	Colourless	Pink
Methyl orange	Orange	Red	Yellow

Natural indicators

Turmeric (Haldi Powder)

- Turmeric paper remains yellow in acidic and neutral solutions but turns brown in alkaline solution.
- The purple colour of cabbage indicator turns red in acidic solutions and green in basic solutions.
- Neutral solutions do not change the colour of red cabbage indicator.

CHAPTER 7 FORCE AND PRESSURE

Pressure, Force and Area

- The force acting normally on unit area of a surface of an object.
- Mathematically, pressure can be defined as: Pressure = Force/ Area
- Pressure is denoted by *P*, force is denoted by *F* and area is denoted by *A*, then the relation can be expressed as: P = F/A
- it can be seen that when same force is applied on different areas, the smaller area will experience high pressure while the larger area will experience low pressure.
- Similarly, when different forces act on the same area, the larger force will exert high pressure while the smaller force will exert low pressure.

7.1.1 Units of Pressure (N m) or pascal (Pa)

- Pressure is a physical quantity whose units can be expressed in terms of units of force and area.
- The unit of force is newton (N) and unit of area is square metre (m^2).
- As pressure is equal to force per unit area, hence, the unit for its measurement is newton per square metre ($N\ m^{-2}$).
- It is the SI unit of pressure. It is also known as Pascal. Pascal is denoted by Pa.

Water Pressure

- The water pressure of the tap depends upon the height of the water tank above the ground floor. That is why, the water tanks are placed on the roof of the top floor. This pressure is transmitted through the pipes to the tap.
- A liquid pressure which increases with the depth of the liquid in a container is called **hydrostatic pressure**.

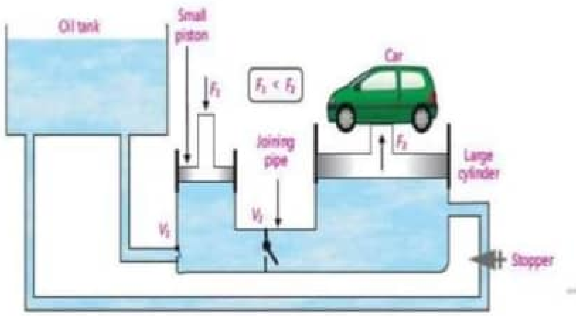
Liquid Pressure in Closed Containers

- The liquids or fluids filled in closed containers exert pressure equally in all directions.
- Pascal's law is only applied to the fluid, filled in closed vessels.
- The branch of science which deals with the transmission of fluid pressure through pipes as a source of mechanical force is called **hydraulics.**

Applications of Pascal's Law - Hydraulic system

Jack system

- a small, force *F* is applied on a small piston which produces pressure *P* on the oil. Pressure *P* is *1* transmitted through the pipe to a very large cylinder fitted with a piston. Since area of this piston is very large. So, a very large force is produced by pressure *P* at this bigger piston which may be used to lift something very heavy such as a car.



- Valves *V* and *V* prevent the back-flow of oil to the small cylinder so that heavy load *1 2* remains raised up. When the oil stopper is opened, the oil in the large cylinder flows back to the oil tank and the load is brought down.
- **Brake system**
- Brake system in the cars is another common example of a **hydraulic system** .
- This consists of a pipe and two cylinders. It is filled with special fluid called brake oil. At one end of the pipe there is a cylinder fitted with a small piston called master cylinder.
- The small piston is connected with brake pedal. At the other end of the pipe there is a second cylinder fitted with a large piston called slave cylinder.
- When small piston is pushed into master cylinder by applying a small force on brake pedal, the pressure thus produced is transmitted without loss to the slave cylinder.
- The large piston in the slave cylinder is pushed out with a large force. It then pushes the brake pad out to make it rub against the moving wheel disc. In this way a large frictional force is produced which stops the running wheel.

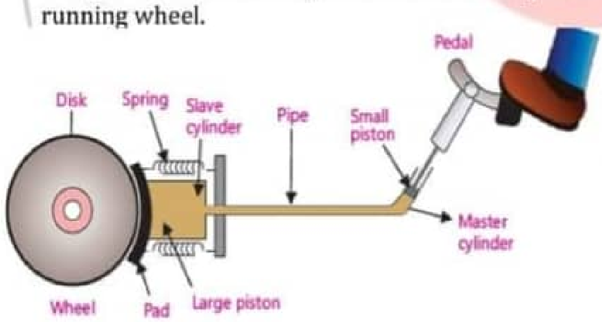


Figure 7.4: Hydraulic brake system

Gas Pressure in a Container

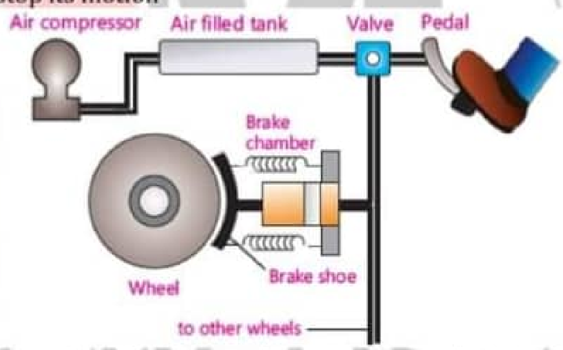
- Molecules of a gas in a container are in a continuous state of random motion in all directions.
- During their motion, they collide with each other and with the walls of the container. Gas molecules colliding with the walls of the container exert force on the walls of the container and thus produce pressure
- If the volume of the container is decreased for the same quantity of gas the distances between the particles also decreases and there are more collisions of the particles with the walls of the container. As a result the gas pressure increases.
- The gas pressure can also be increased by adding more gas in the container. Addition of more gas molecules means more collisions with the walls of the container and hence more pressure.

Pneumatics

- Compressed air has the ability to do some mechanical work.
- The branch of science which deals with the study and applications of pressurized gas to produce mechanical motion is called **pneumatics**.

Applications of compressed air

- Automobile tyres are inflated with compressed air for smooth running of vehicles.
- Spray guns use compressed air for spraying paint
- Air powered motors use compressed air to work. Such motors are used at the places where electric motors are not suitable for safety reasons.
- Compressed air is used to operate air-powered (pneumatic) tools like hammers, drills, etc.
- The compressed air is also used in air brake system in heavy vehicles. When a brake pedal is pressed, the compressed air is released from the storage tank. This air pushes the brake pad against the moving wheel to stop its motion



- Most of the dentistry tools use compressed air for their working.

Aerosols

- The products using 'sol' systems are called aerosols. "Sol" is a mixture of suspended solid or liquid particles in a gas or air.
- Different types of aerosols are used for various purposes .
- They are used as air fresheners, insect repellents, hair sprays, cleaning agents, spray paints, medicinal sprays (like inhalers.) etc.

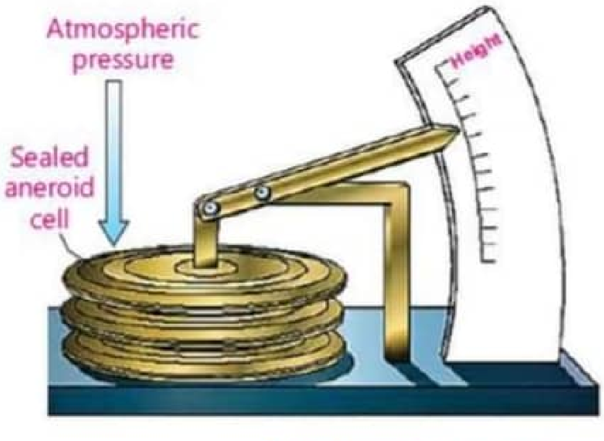
Atmospheric Pressure

- Our Earth has a blanket of air around it.

- The Earth's gravity pulls the air column down. Hence, the air has weight.
- The weight of the air column (force) per unit area on the Earth is pressure which is termed as atmospheric pressure.
- Atmospheric pressure =Weight of the air/Area
- The instrument used to measure the atmospheric pressure is called **barometer**.
- The unit for measuring atmospheric pressure is the standard atmosphere.
- The standard atmosphere is abbreviated as **atm**.
- One atmosphere (1 atm.) is equal to 101,300 Pa or 101.3 kPa at sea level.

Atmospheric pressure varies with altitude

- The Earth's surface where we live is the bottom of the sea of air. There is more weight of the air and hence more atmospheric pressure at the Earth's surface.
- As we go up in the air, atmospheric pressure decreases. This is because weight of air decreases as we go up in the air. Thus the people who climb up the hills experience less air pressure than those living at sea level.
- At sea level the atmospheric pressure is 101300 Pa (101.3 kPa) whereas, at a height of about 5km it falls to about 55000 Pa (55 kPa).
- Altitude above the sea level can be determined on the basis of the measurement of atmospheric pressure. The lower the atmospheric pressure the greater is the altitude.
- When a barometer is calibrated to indicate altitude, the instrument is called **pressure altimeter**
- Pressure altimeter is used in air crafts. Wrist-mounted altimeter is used by sky divers, hikers and mountain climbers.



Pressure altimeter

CHAPTER 8 MEASUREMENT OF PHYSICAL QUANTITIES

Physical Quantities

- The quantities which can be measured are called physical quantities.
- Length, mass, time,volume, etc., are the examples of physical quantities.
- Physical quantities have at least two things in common.
- One is the size or magnitude and the other is the unit in which the quantity is measured.
- For example, to describe a brick, its length, width, height and mass are measured. These are called physical quantities.

International System of Units

- There is a need of some standard quantity for measuring unknown quantity. This standard quantity is called unit.
- Various standard units have been in use at different times in different parts of the world. With the passage of time, these units were made more precise and acceptable.
- People especially business communities and scientists of different countries faced problems of converting the units into one another. This problem was solved in a conference of the scientists from all over the world held in Paris.
- In 1960, the eleventh general conference of International Committee on Weights and Measures recommended that all countries of the world should adopt a system of same kind of standard units. This conference recommended the use of International System of units. It is abbreviated as SI.
- According to this system, the units of length, mass, time and volume are given in the following table.

Physical Quantity	Symbol	Unit	Symbol
Length	L	Metre	M
Mass	M	Kilogram	Kg
Time	T	Second	S
Volume	V	Cubic metre	M3

- A practical unit of volume is litre (L). Mostly the litre is used for measuring volume of liquids such as milk, petrol, cooking oil, etc. It is 1/1000th part of a cubic metre (m^3). Therefore 1 m^3 = 1000 L Also 1 L = 1000 millilitre = 1000 cubic centimetre (cc)

Prefixes

- The main advantage of SI units is that their multiples and sub-multiples can be conveniently expressed using prefixes. Prefixes are based on multiplying and dividing the units by powers of 10.
- The words or letters added before SI units such as milli (m), centi (c) and kilo (k) are known as prefixes.
- Milli means 1000 part. For example, millimetre (mm) is 1000 part of a metre, i.e., 1/1000 m. It means, 1 m = 1000 mm.
- Centi means 100 part. For example, centimetre (cm) is 100 part of a metre, i.e., 1 cm = 1/100 m. It means 1 m = 100 cm.
- Kilo means 1000 times. For example, kilometre (km) is 1000 times of a metre, i.e., 1 km =1000 m.

- Thus, diameter of a thin wire can be written in smaller units of centimetre (cm) or millimetre (mm) instead of metre. Similarly, the longer distance between two cities may be expressed better in a bigger unit of distance, i.e., kilometre (km).

Examples

- **Convert 5 m into mm.**
  5 m = 5 ×1,000 mm
  = 5,000 mm = 5×10^3 mm

- **Convert 50 m into cm.**
  50 m = 50 × 100 cm
  = 5,000 cm = 5×10^3 cm

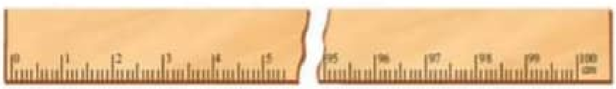
- **Convert 20,000 g into kg.**
  20,000 g = 20,000 ÷ 1,000 kg
  = 20 kg

Measuring Instruments

- Measuring instruments are used to measure various physical quantities such as length, mass, time and volume etc. We shall now describe some measuring instruments used in the laboratory.

Metre Rule

- A metre rule is one metre long graduated stick.
- It is usually used to measure length of an object or distance between two points.
- A metre rule is divided into 100 equal parts, each part is equal to one centimeter.
- Each centimetre is further divided into 10 millimetres. Thus, a metre rule can measure the length of an object correct upto one millimetre.



Metre rule

- While measuring length or distance between two points, eye must be kept vertically above the reading point.
- If the eye is positioned either left or right to the measuring point.the reading will become doubtful.

(a) Correct reading (b) Incorrect reading

Figure 8.2

Measuring Cylinder

- A measuring cylinder is used to measure the volume of a liquid. It is made of glass or transparent plastic.
- It has a scale in millilitre (mL) or cubic centimetre (cm^3) along its length. That is why, it is also called graduated cylinder.
- Measuring cylinders of different capacities (from 5 mL to 500 mL) are very common..

Flasks

- Flasks are laboratory vessels (containers). They are made of glass or plastic.
- Flasks are available in many shapes and sizes.
- Their sizes are specified by the volume they can hold.
- These are graduated in the units of cubic centimeter (cc) or millilitres (mL).
- Flasks are used for making solutions.

Pipette

- Pipettes are commonly used in chemistry and biology laboratory to measure the volume of a liquid in a smaller quantity. Pipettes have several shapes and sizes.
- These are graduated to a specific mark.
- These are commonly available in the sizes of 10 mL to 25 mL. Pipettes are made of glass or plastic.

CHAPTER 9 SOURCES AND EFFECTS OF HEAT ENERGY

- Heat is an essential requirement for life.
- In addition to keeping our bodies warm, we need heat for ripening crops and fruits, keeping the Earth's environment warm, melting of ice on the mountains and in the preparation of a large number of industrial products..

Sources of Heat

- Sun is the biggest source of heat.
- Sun's heat reaches the Earth in the form of radiations.
- Solar radiations keep the Earth environment warm at a suitable temperature for the survival of life

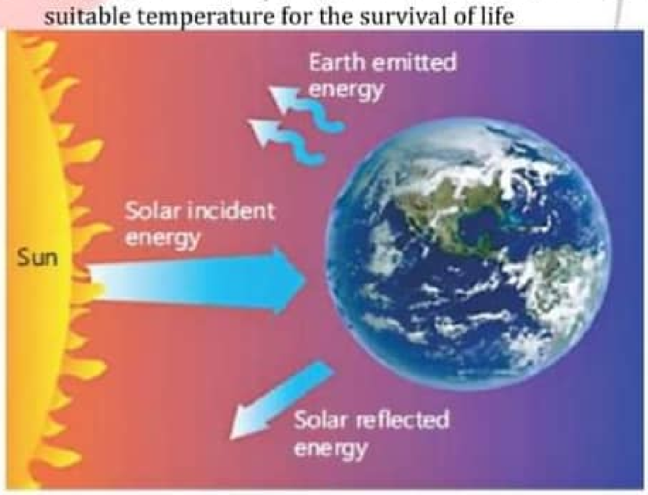


Figure 9.1: Solar radiations keep the Earth warm

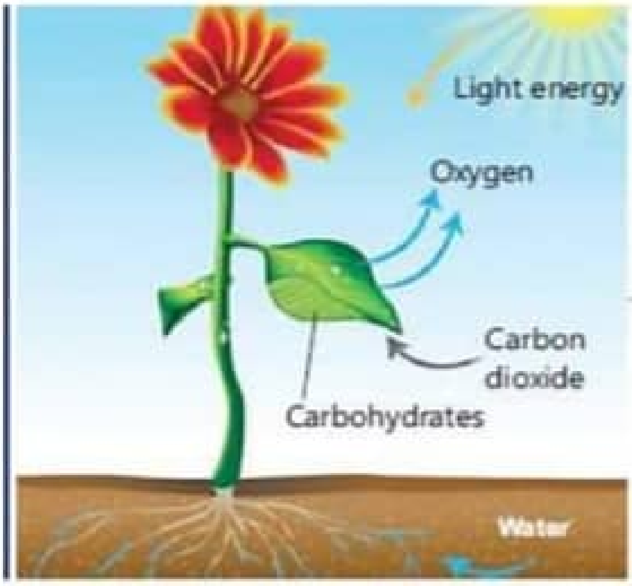


Figure 9.2: Solar radiations used by plants

- We keep our bodies warm and alive by the heat produced from the food during its metabolism in the body cells.
- Heat is also produced by burning of wood, coal, oil and gas, etc.
- We cook food and warm our rooms by the heat produced by burning of wood and natural gas, etc.
- Heat produced by the burning coal and oil etc. is used to produce electricity in thermal power stations
- Electricity is also used to produce heat

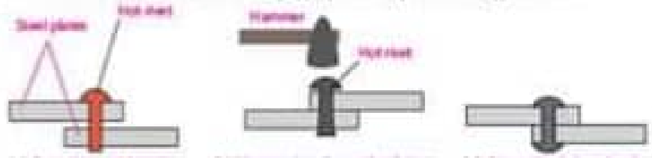
Effects of Heat

- All kinds of material objects are made up of tiny particles such as atoms and molecules.
- When an object is heated, the object expands. This expansion of material objects on heating is called **thermal expansion**.
- On the other hand, when an object is cooled, the object contracts. This contraction of material objects is called **thermal contraction**.
- The degree of expansion and contraction in solids depends on the nature of substances.
- Some solids expand or contract very little and we may not notice their expansion or contraction on heating or cooling.
- Different metals expand or contract at different rates.
- For example; one metre long brass rod increases 1 mm in length when its temperature increases by 100 °C but iron rod of the same length expands only 0.6 mm for the same increase in temperature.
- Like solids and liquids, gases also expand on heating and contract on cooling.

Applications of Expansion and Contraction of Solids

Riveting

- A rivet is a small, cylindrical and smooth shaft whose one end is swollen (called head) while the other end is flat (called buck-tail)
- Hot rivets are used to join the metal plates.
- The process in which two metal plates are joined together by means of rivets is called riveting.
- For joining the two steel plates, they are placed one above the other and holes are drilled through them. The rivet is heated to make it red hot and is inserted in the holes of the plates.The ends of the rivet are then hammered into a round shape .When the rivet cools and contracts, it firmly grips the plates together.



(a) Inserting red hot rivet in the holes of plates (b) Hammering the ends of rivet (c) On cooling, rivet firmly grips the plates

Figure 9.9: Riveting

Fixing a Metal Tyre Over the Wheel

- The metal tyres which are fixed over the wooden wheels of the carts are slightly smaller than the wheels when they are cold.
- On heating, the metal tyre expands and its diameter increases.
- Then hot tyre can easily be fitted onto the wheel. On cooling, the metal tyre contracts and fits over the wheel tightly

Fixing Axle into a Wheel

- This method is mostly used to fit in the axle of train wheels. In this method, contraction is used instead of thermal expansion.
- The diameter of the axle is slightly larger than the hub of the metal wheel. The axle is placed in liquid nitrogen which is below -196 °C temperature.
- The axle cools and contracts. It is then inserted into the hub of the wheel and is allowed to come at room temperature.
- At room temperature, axle expands and fits into the wheel tightly

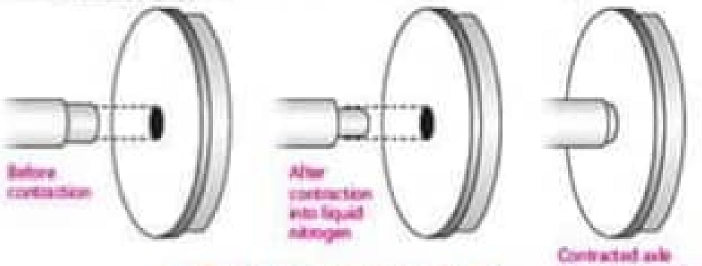


Figure 9.11: Fixing axle into the wheel

Applications of Bimetallic Strips

- Bimetallic strips are used in thermostats.
- A thermostat is a device that is used to control temperature in electrical appliances such as electric irons, heaters, refrigerators, air conditioners, ovens, and stoves etc. It is also used in fire alarms.

Electric Iron

- In an electric iron when electric current flows through its heating element, it becomes hot.

- The bimetallic strip connected with the heating element through a spring also begins to heat up.
- On getting hot, bimetallic strip bends and is disconnected from the heating element. This makes the circuit open and switches OFF the electric iron. On cooling, the bimetallic strip straightens. The circuit is again closed and the iron is switched ON.

Fire Alarm

- In case the fire breaks out, the bimetallic strip used in the fire alarm gets hot and bends to touch with the contact point of the battery.
- In this way the circuit is completed, and the bell connected in the fire alarm circuit begins to ring to warn of the fire.

Effects of Expansion and Contraction of Solids in Everyday Life

Expansion Gaps in Concrete Roads

- In hot summer, the concrete used to build roads expands. If no space is provided for its expansion, the road surface cracks.
- To avoid such damage, small gaps are left after every few metres in the construction of concrete roads or footpaths.

Railway Tracks

- Two sections of a railway track are not welded together. Instead they are laid with gaps between them. This allows expansion and contraction of rails during summer and winter seasons.
- f there are no gaps in the sections of railway tracks, they may de-shape due to expansion in summer.

Expansion gap in railway track

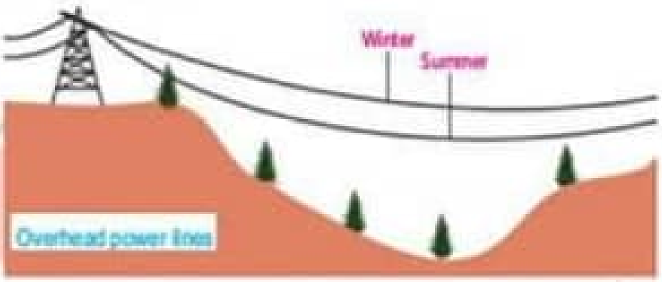
De-shaped railway track

Expansion of Bridges

- Iron girders are used in the construction of bridges.
- One end of each girder is fixed while the other end rests on the rollers.
- A gap is also left at this end .In this way, the girder can move forward or backward during expansion or contraction. If there is no expansion gap, bridges may get damaged.

Overhead Power Lines and Telephone Wires

- Overhead telephone and electricity wires installed on poles expand during hot weather and contract in cold weather.
- The wires between two poles are given a certain amount of sag so that they may contract in winter without snapping.



Large Bends in Pipes

- The pipes through which hot or cold liquid or gas flows are often given bends so that they may expand or contract without cracking.

Uses of Expansion and Contraction of Liquids

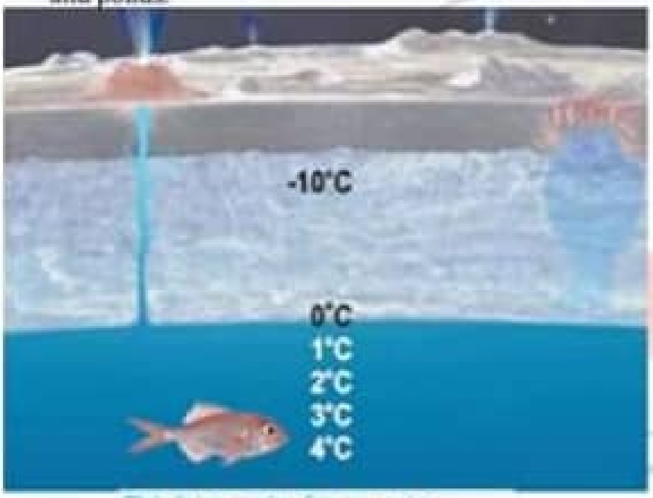
Thermometer

- The expansion and contraction property of liquids is widely used in different techniques.
- For example; liquids like mercury and alcohol are used in thermometers.
- A thermometer is a device that is used for measuring temperature.
- When the bulb of the thermometer is touched with some hot object, the liquid inside the narrow tube of the thermometer expands and rises up and the temperature of the hot object can be read on the scale.

Peculiar Behaviour of Water

- The behaviour of water with rise or fall in temperature is different from other liquids.

- When temperature of water is increased from 0 °C to 4 °C, it contracts, its volume decreases and its density increases.
- On cooling from 4 °C to 0 °C, water begins to expand, its volume increases and its density decreases. At 0 °C water freezes.
- Due to this peculiar behaviour, when water freezes, it expands and density of ice becomes less than water. That is why ice floats on water surface. In this way, aquatic life (fish, etc.) survives underneath frozen lakes and ponds.



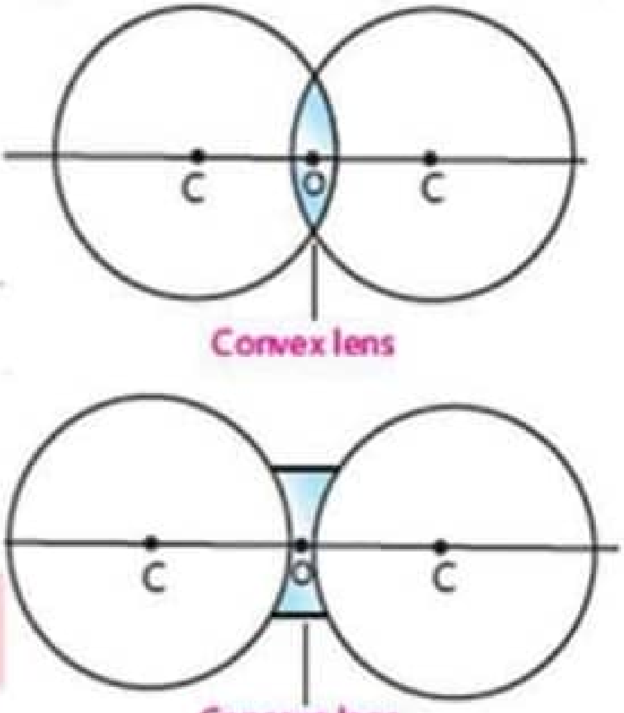
Fish living under frozen water

CHAPTER 10 LENSES

- Light, when enters from a lighter medium (e.g., air) to a denser medium (e.g., glass), it bends towards the normal.
- Conversely, when light enters from a denser medium (e.g., glass) to a lighter medium (e.g., air), it bends away from the normal.
- The main application of refraction is the image formation through lenses.

Lenses

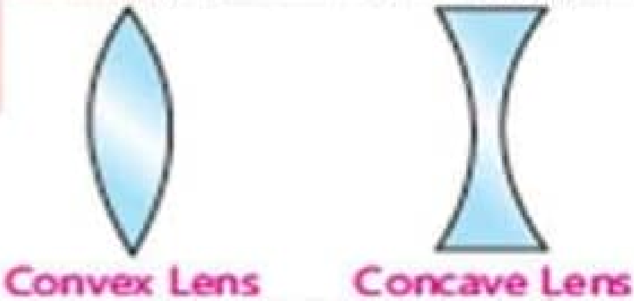
- Lenses are widely used in our life.
- Many eyesight defects are corrected by the use of lenses. Lenses are commonly used in spectacles, cameras, microscopes, telescopes, binoculars, projectors and many other instruments for different purposes.
- Contact lenses are also becoming very popular these days.
- These can be placed in eyes and removed easily when needed.
- A lens is a piece of any transparent material (like glass) with two faces, of which at least one is curved.
- Each surface of a lens is a part of a sphere.
- The centre of such a sphere is called **centre of curvature** (C).
- The centre of the lens is called **optical centre** (O).
- The line passing through the optical centre and centre of curvature of the faces of the lens is called **principal axis** or **optical axis**



Centre of curvature and principal axis of the lenses

Types of Lenses

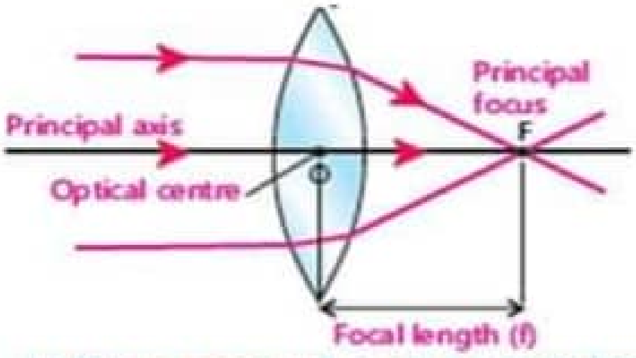
- There are two types of lenses; **convex lens** or converging lens and **concave lens** or diverging lens



- A convex lens is thicker in the middle and thinner at the edges.
- A concave lens is thinner in the middle and thicker at the edges.

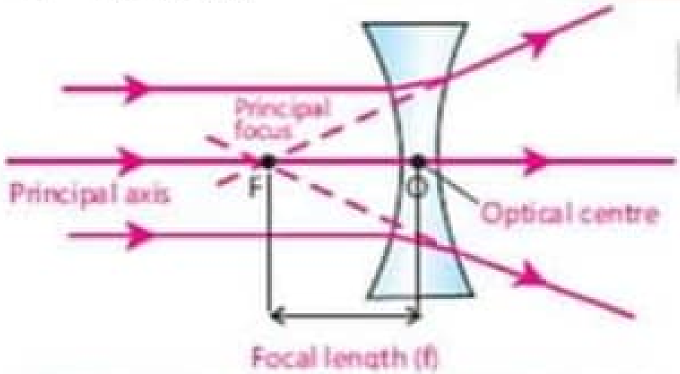
Principal Focus (F) and Focal Length (f) of the Lenses

- In case of convex lens the light rays parallel to the principal axis after refraction through the lens meet at a point.
- This point is called **principal focus** (F) or focus point of convex lens



Light rays passing through a convex lens

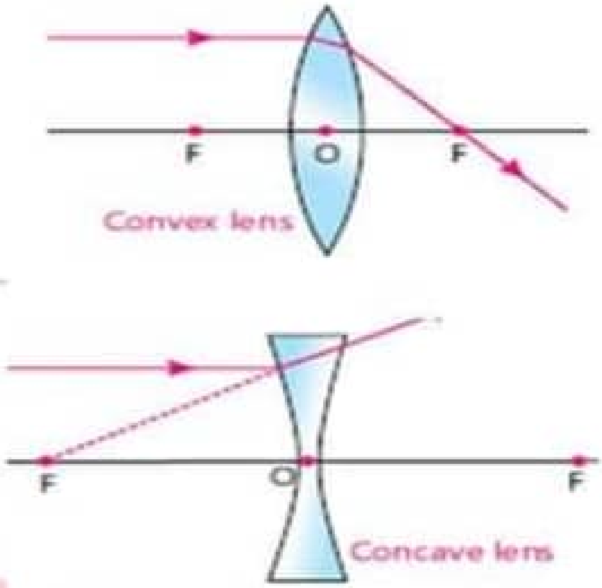
- As the light rays actually meet at the focus point after refraction through the convex lens, so the focus point is 'real'.
- The distance between the optical centre (O) and focus point (F) of the lens is called **focal length** (f).
- Focal length of a convex lens is taken as positive.
- Since a convex lens actually converges light at principal focus (F), that is why, it is also known as converging lens. Because of this property, convex lens makes real image on the screen placed on the other side of the lens.
- In case of concave lens, light rays parallel to the principal axis after passing through the lens bend in such a way that they do not meet at one point. They diverge out and appear to be coming from one point which is called principal focus.
- The principal focus of a concave lens is 'virtual'. The focal length of a concave lens is taken as negative. The image is not formed on the screen by a concave lens



Light rays passing through a concave lens

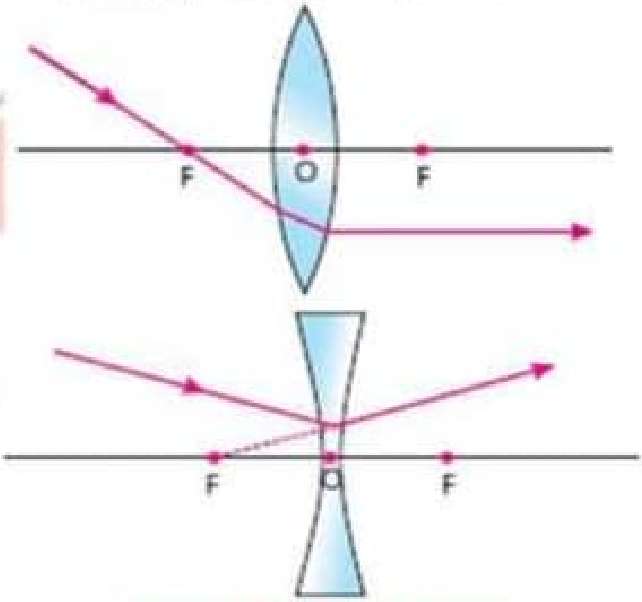
Image Formation by the Lenses

- The arrow heads show the direction of light ray.
- A ray parallel to the principal axis after refraction from a convex lens passes through its principal focus (F). In case of concave lens, the refracted ray appears to come from the principal focus (F)



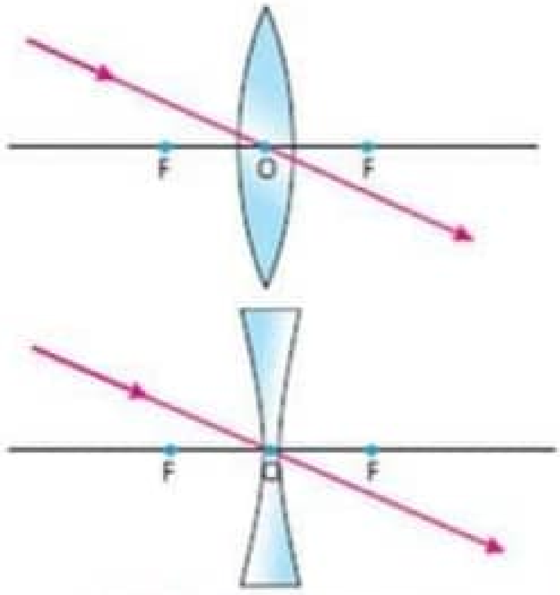
Refraction through lenses

- A ray incident on the convex lens after passing through its principal focus (F) becomes parallel to the principal axis after refraction. In case of a concave lens, the ray pointing towards the principal focus appears to come from the principal focus after refraction



Path of ray through lenses

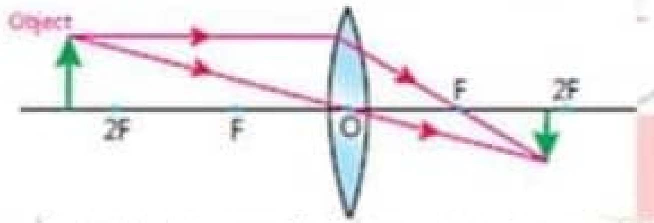
- A ray passing through the optical centre of the lens goes straight without changing its direction



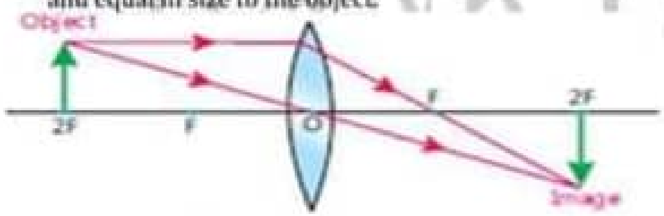
Path of ray through lenses

Image Formation Using a Lens by Ray Diagram

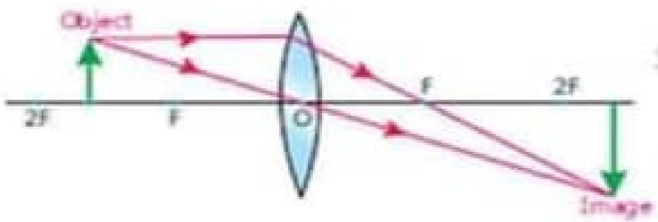
- When the object is placed beyond 2F, the image is formed on the other side of the lens between F and 2F. The image is real, inverted and smaller in size than the object.



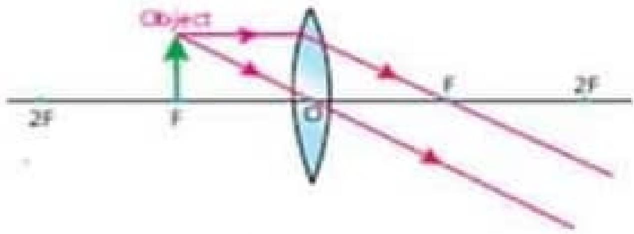
- When the object is at 2F, the image is also formed at 2F on the other side of the lens. The image is real, inverted and equal in size to the object.



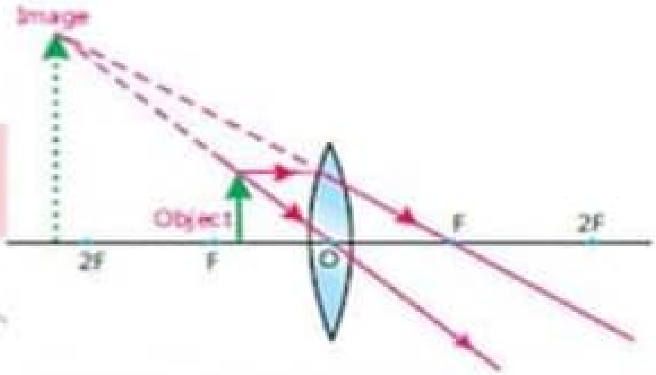
- When the object is between F and 2F, the image of the object is formed beyond 2F on the other side of the lens. The image is real, inverted and larger in size than the object.



- When the object is at F, the image of the object is formed at infinity. It cannot be shown in the diagram because rays become parallel after refraction.

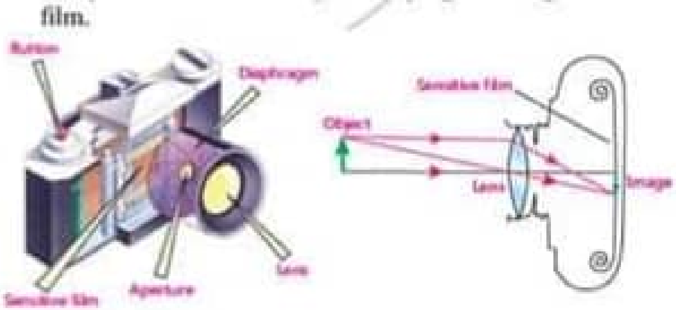


- When the object is between O and F, rays after refraction diverge out and do not actually meet on the other side of the lens. A virtual image will be formed at a point where the rays meet when extended backward. These rays will appear to come from the image. The image will be magnified and erect.



Camera

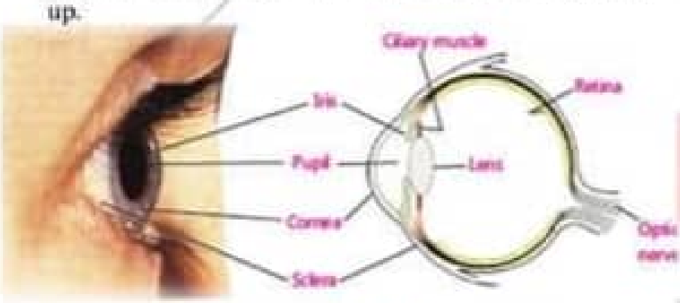
- Camera is a kind of box to which a convex lens is mounted on the front side.
- The lens forms a real and inverted image of an object on the sensitive film placed behind it.
- A system is provided in the camera to move the lens back and forth so that sharp image is obtained on the film.
- There is shutter behind the lens that remains close normally.
- When the button is pressed, the shutter opens for a while. Light coming from the object enters the camera during this interval and image is formed on the film.
- The amount of light entering into the camera depends upon the size of aperture.
- Aperture is an opening in the diaphragm behind the lens. This can be made smaller or larger as required. The picture is obtained by developing the image on the film.



Human Eye

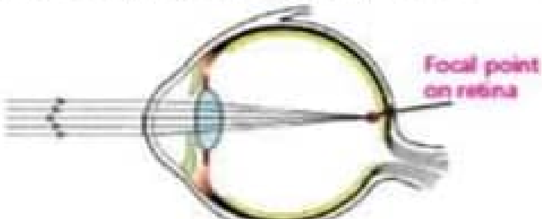
- The human eye also works like a camera.

- Different parts of eye are shown in The eye is almost a sphere of diameter about 2.5 cm. Its outer boundary called the sclera is thick and hard.
- At the front of the eye, there is a transparent hard skin known as cornea.
- Behind the cornea there is iris and after that there is convex lens.
- The inner layer of the back wall of eye is called retina.
- The retina of eye and the film of camera serve the same purpose. Like camera, the eye lens forms a real and inverted image of the object on retina.
- The optic nerve carries it in the form of signals to the brain.
- Although the image formed on the retina is inverted, but our brain interprets this correctly i.e. the right way up.

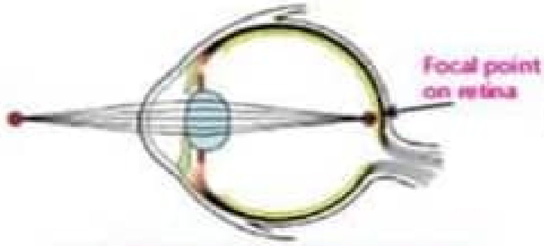


Human eye

- The iris acts like the diaphragm of camera.
- The opening at the centre of iris is called pupil which is just like aperture of a camera.
- When light outside is dim, the iris contracts to make the pupil larger so that more light can enter the eye. In bright light, the iris makes the pupil smaller.
- In a camera, lens is moved back and forth to focus the image on the film, but the eye lens does not move. Instead, the ciliary muscles make the lens thick or thin due to which its focal length changes



(a) Ciliary muscle relaxed, lens flattened for distant vision



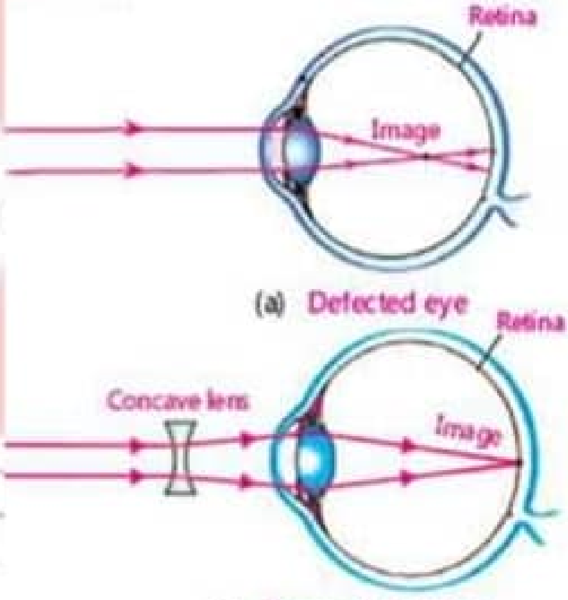
(b) Ciliary muscle contracted, lens rounded for close vision

- When you are looking at distant object, the ciliary muscles are in relaxed position and the image is formed on the retina. To look at something closer to the eye, these muscles make the lens thicker. This makes its focal length shorter and the image is again formed on the retina instead of forming at a point beyond it.

Defects of Human Eye

Short-Sightedness

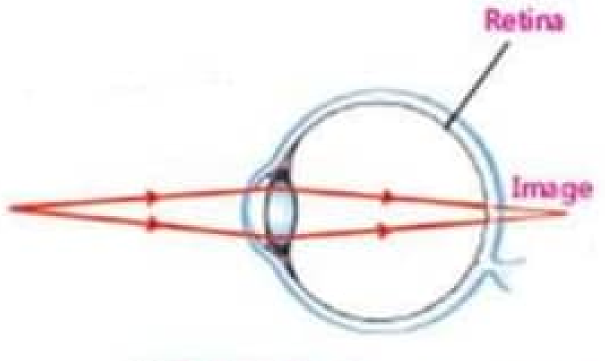
- A person with this defect can see near objects clearly but distant objects appear blurred.
- This defect is caused when the eye lens becomes much thicker or eyeball becomes too long. The image of distant object is formed in front of the retina and not at the retina itself.
- This defect is also known as myopia and is corrected by using concave lens of suitable focal length.
- The concave lens diverges the light rays before they enter the eye and hence, the rays are refracted by the eye lens again to meet at the retina



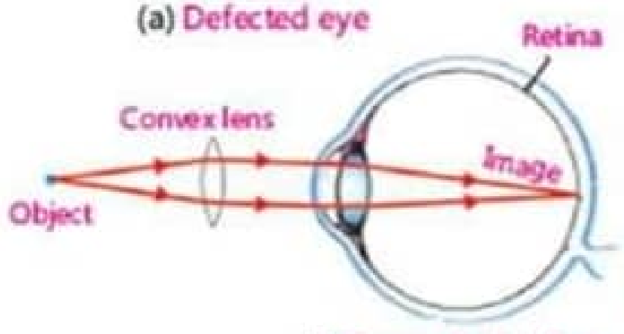
(b) Removal of defect
Correction of short-sightednes

Long-Sightedness

- A person having this defect can see distant objects clearly but near objects appear blurred.
- This defect is caused when the eye lens becomes thin or the eyeball becomes too short.
- Due to this effect the image of the near object is formed beyond the retina. That is why the near object appears blurred in long-sightedness.
- This defect is known as hyperopia and is corrected by using suitable convex lens.
- The convex lens converges light rays before they enter the eye. After entering the eye, they are further bent by the eye lens to meet at the retina .



(a) Defected eye



(b) Removal of defect

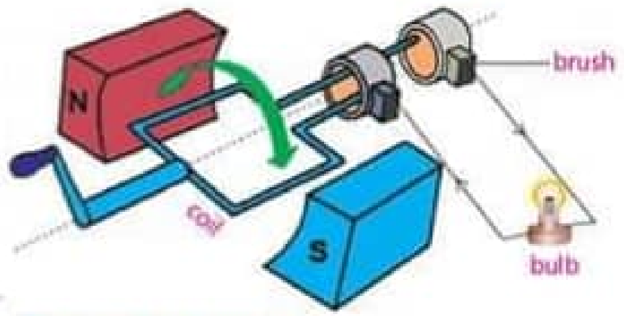
Correction of long-sightedness

CHAPTER 11 ELECTRICITY

- Although electricity and magnetism were well known for centuries but Hans Christian Oersted a Danish Scientist in 1820 discovered a connection between them.
- Hans Christian Oersted a Danish observed that current flowing through a coil of wire produces a magnetic field around it. In this way, he proved that a magnetic field can be produced by an electric current.
- In 1831, a British Scientist Michael Faraday discovered that the reverse of this phenomenon is also possible. He observed that when a loop of wire was moved quickly between the two opposite poles of a magnet, an electric current was produced in it. This fascinating discovery changed this world into a magic world.

How Electricity is produced?

- No fans, computers, refrigerators and other electrical appliances in our homes can be run without electricity.
- Electricity can be generated from many different sources by different methods.
- Dry cells and batteries produce electricity by chemical reactions of compounds.
- Electricity can also be produced by some mechanical ways.
- Just as we can make magnets from electricity, we can also use magnets to produce electricity.
- Electricity can also be produced by rotating a coil between the opposite poles of a magnet



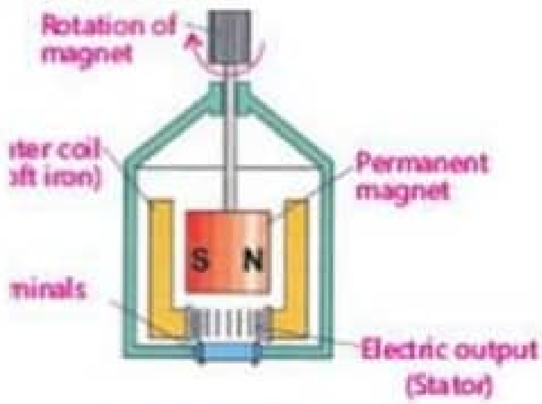
Working of a generator

The mechanical system to produce electricity in this way is called electric generator or dynamo

- The current produced by electric generators is not unidirectional. Its direction changes again and again after an equal interval of time. Such a current is called alternating current (A.C).
- For the production of electricity of higher voltage, a generator should have stronger magnets, more turns in its coil and quick relative motion between the magnet and coil

Bicycle Dynamo - a Small Generator

- Your bicycle may have a dynamo to light up its lamp.
- The dynamo is a small portable generator which produces electricity from the energy of your body when you pedal a bicycle.

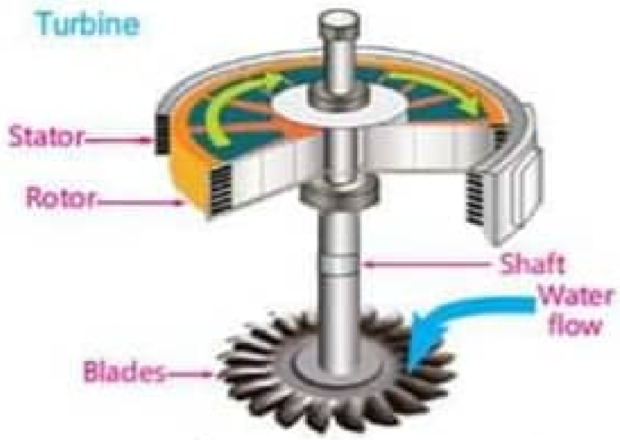


Working of a dynamo

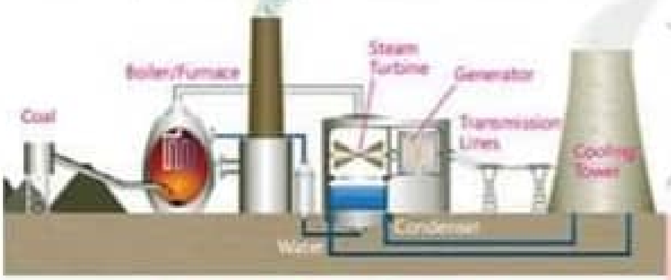
- . The working principle of this small generator is the same as that of a big generator. In a dynamo the coil is held stationary while the magnet rotates inside the coil with the rotating wheel of the bicycle.

Power Plant Generators

- The development of a country highly depends on the availability of the power resources.
- Electricity is mostly generated in places called power stations.
- In a power plant generator, the coils are kept stationary while magnet is rotated inside the coil.
- The stationary coil is called stator while the moving magnet is called rotor.



- The running water of a stream or a river is used to run generator for producing electricity.
- Similarly, fuels like coal, oil or gas are also used to run generators.
- In coal-fired electricity generation, the burning coal heats water in a boiler, producing steam. The steam pushes the blades of a turbine fixed at the lower end of the rotor shaft. As the rotor spins inside the stator, electric power is generated .



Generation of coal-fired electricity

- In a hydro power station, water falls down from a high reservoir (lake) through the tunnels. The falling water turns the blades of a turbine fixed to the lower end of the rotor shaft. The rotating shaft turns the rotor, which generates electricity in the stator coils .
- The electricity is transmitted to various parts of the country through power transmission system.
- Hydro power generation is very economical and environmental friendly.

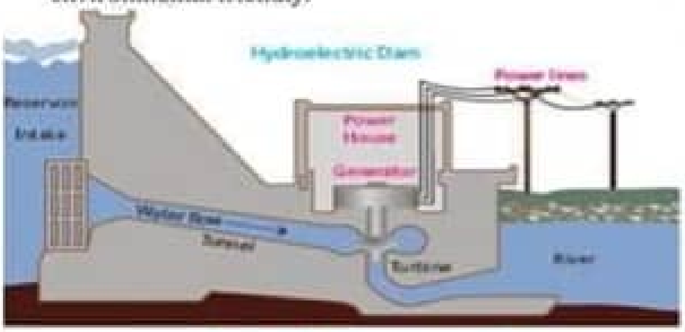


Figure 11.6: Hydro power generation

Energy Sources to Generate Electricity

- Electricity is not only generated by mechanical generators but there are some other ways as well to generate electricity. But due to the continuous increase in prices of gas, oil and coal the cost of electricity is becoming unaffordable for people.
- Scientists are now searching the most cheaper ways to generate electricity.
- Sources used most often in the modern technology are solar, nuclear, wind and biomass energy to generate electricity.

Solar Energy

- Solar energy is used through solar panels which are an inter-connected assembly of photo voltaic cells that produce electricity in the brighter sunlight.
- During daytime, this electricity can be used directly to run appliances. It can also be stored in batteries for use during night.
- Solar electricity is environmental friendly.
- The trend to generate electricity by solar penals is increasing day by day in Pakistan due to the increase in prices of traditional thermal electricity.

Wind energy

- The kinetic energy of wind in coastal areas is used to turn huge blades mounted on high poles.
- The turning blades run the generator to produce electricity.

Nuclear energy

- When nuclei of heavy elements are broken by a special process called 'fission' a large amount of heat energy is released.
- This heat is used to make steam that rotates the turbine which runs the electric generator.

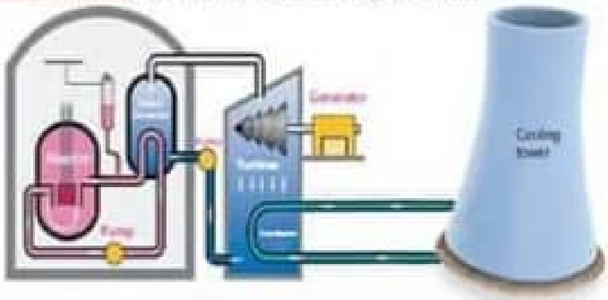


Figure 11.9: Nuclear power plant

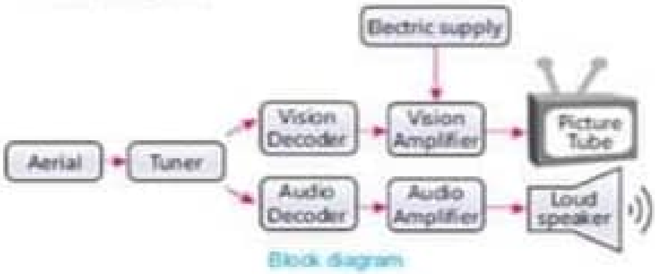
Problems Involved in Generating Electricity

- Hydroelectric power is one of the commonly used methods of producing electricity. It is the cheapest way of getting electricity, but some problems are there in this method. For hydroelectric power generation dams are constructed. The water table in the nearby areas of a dam rises which causes water logging and land becomes uncultivable. In winter due to the shortage of water, electricity cannot be generated on large scale. Moreover, the population of area is shifted to some other places if a dam is to be constructed in that area.
- Electricity production by thermal energy needs fossil fuels (oil, gas, coal). These are non-renewable energy sources. That is why are running short day by day and their prices are shooting up. Moreover, fossil fuels release smoke and other harmful gases in the atmosphere.

- Many advanced countries use nuclear energy for production of electricity. Although it is not very expensive but sometimes it becomes very risky. The danger of harmful radiation leakage is always there. Another problem with this method is the proper disposal of waste material which is also highly radioactive.
- Solar power is becoming very popular these days. Solar energy is renewable source of energy and is available to everyone free of cost. Production of electricity by using solar energy is safe and causes no pollution, but still has certain problems. The major problem is the high initial cost of solar panels and storage batteries.
- Wind energy is also a renewable source of energy. It does not produce pollution The initial cost is very high. Moreover, wind farms cover large areas of expensive land and are very noisy.

Electronic Systems

- We are living in an electronic age.
- Radio, television, computer, amplifiers, hi-fi sound system, worldwide communication systems, mobile phones, artificial satellites etc., are common electronic systems.
- They use electricity to perform their functions like processing input data and obtaining, altering, transmitting or storing information.
- All these functions are done by controlling the motion of electrons.
- The branch of physics that concerns with the behavior and control of motion of electrons is called **electronics**.
- Electronic systems use short pulses of electric current to carry information in the form of signals.
- Later on, these signals can be changed into sounds, pictures or other information. A well-known example of an electronic system is television.
- Without going through the details of internal working of its different parts, we can describe its functions by a block diagram.



Block diagram

The following steps will explain how the system operates:

- A camera converts picture and a microphone converts sound into electronical signals at the TV station.
- These signals are mixed with carrier waves and are transmitted through transmitter antenna or cable.
- Signals are received by TV in the form of a weak alternating current.
- These signals are amplified by the amplifiers already installed in the TV.
- The circuits inside the TV separate video and audio signals.
- Video signals go to the picture tube that displays motion picture on the screen.
- Audio signals go to the speaker that converts them back into sound.

Basic Components of an Electronic System

- Resistors, semiconductor diodes, transistors, silicone chips and integrated circuits (ICs) are some basic components of an electronic system.

Semiconductors

- Semiconductors are materials in which motion of electrons can be controlled.
- The most common semiconductor material is silicone.
- The devices made from semiconductor materials are widely used in electronic systems to amplify and process electronic signals.
- Two most common semiconductor devices are semiconductor diode and transistor.

Semiconductor Diodes

- Semiconductor diode is a device in which electric current can flow in one direction.
- A semiconductor diode has two terminals P and N. Current can flow from P to N but not in opposite direction.
- For this reason, semiconductor diodes are often used for converting alternating current into direct current.

Transistors

- A transistor is a semiconductor device with three terminals.
- Transistors are used as switches.

Integrated Circuits

- Very tiny electronic circuits are called integrated circuits.
- These are commonly called as Ics.
- An integrated circuit consists of a tiny silicone chip with many components incorporated on it.
- In some ICs, about 1000 components are constructed on just a 3 mm square silicone chip.
- Before the advent of ICs, components in an electronic circuit were connected to one another by connecting wires that took too much space.
- ICs eliminated the need of such clumsy wiring.

Uses of Various Devices (Input, Processor, Output)

- Electronic devices are mainly of three types (i)Input devices (ii) Processors (iii) Output devices

Input Devices

- Any device that changes non-electronical energy into electrical energy in an electronic system is called an input device.
- A microphone is an input device. It converts sound into electrical signal.

- Similarly, an electronic camera also converts a picture to electrical signals. Both are input devices.
- Other examples of input devices are the 'keyboard' and 'mouse' which are used to enter information into a computer.
- Scanner is also an input device.
- These devices feed information, pictures and documents etc. to the computer in the form of electrical signals.

Processors

- A processor is the main component in an electronic system that converts the 'input' into 'output'.
- Amplifier, tape recorder, television etc. are also common processors.
- The amplifier increases the energy of electrical signals of sound fed by the microphone and sends them to the loudspeaker.
- The television converts the electrical signals fed to it through antenna or cable, into picture and sound.
- The microprocessor of a computer is a very good example of it. It controls different parts of the computer to display output result on the screen of monitor.

CHAPTER 12 EXPLORING SPACE

Telescope, Spectroscope and Spacecraft

Telescope

- The instrument which is used for observing distant objects is called telescope.
- Galileo was the first who invented and used telescope in 1610.
- The invention of telescope opened the gate way to scientific study of space and heavenly bodies in different ways.
- The modern telescopes are much bigger and equipped with latest accessories.

Types of Telescope

- Optical telescopes are of two basic types, i.e., refracting telescope and reflecting telescope.

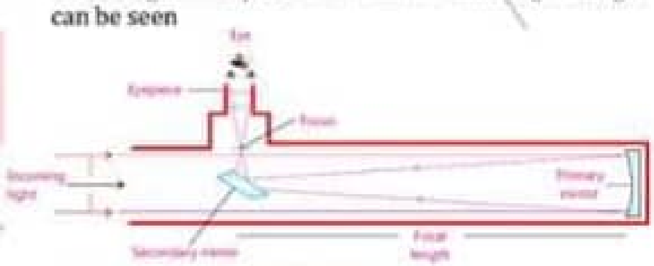
Refracting Telescope

- A simple refracting telescope consists of a long tube fitted with two lenses one at each end of the tube.
- The lens which refracts the light coming from distant objects at a point (focus) is called **objective lens**.
- The lens through which the image formed by the objective lens is seen is called **eyepiece**

Working of Refracting Telescope

Reflecting Telescope

- The main parts of a reflecting telescope are a large concave mirror, an eyepiece and a tube that holds them.
- The **objective mirror** which is a concave mirror reflects and converges the light on an eyepiece directly or through another reflecting mirror.
- The eyepiece magnifies the image formed by the objective mirror.
- Reflecting telescope can be made much larger than a refracting telescope, so that a better and bright image can be seen



Working of reflecting telescope

- Ground based telescopes have the disadvantage that dim light coming from stars passes through atmosphere, and the images so formed are not clear.
- In order to overcome this problem, telescopes have been sent into space.
- Hubble space telescope is the first space-based reflecting telescope launched in 1990 .
- It orbits around the Earth at a height of 600 km and works round the clock. It has taken clear pictures of galaxies, billions of kilometres away.

Spectroscopes

- A spectroscope is an instrument which is used to examine different wavelengths (colours) of a light.
- It consists of a series of prisms that split white light into different colours.
- The set of different colours obtained in this way is called **spectrum**.
- Spectroscope also measures the wavelengths of different colours of the spectrum.
- The wavelengths of light coming from the stars help the scientists to know about the elements and compounds present in the stars.
- Spectroscopes are mostly attached with the telescopes.

Spectroscope

Spacecraft

- Spacecraft is a vehicle designed to travel in space.
- It is used for different purposes like communication, Earth's observation, meteorology, navigation, planetary exploration and transportation of humans and cargo in space.
- There are two major classes of spacecraft; robotic space craft and manned spacecraft. Robotic spacecraft are sent into space for collection of data about space, planets and other heavenly bodies such as asteroids.
- A robotic spacecraft is controlled from the centre on Earth.
- Voyager I and voyager II were two robotic spacecrafts which were used for collecting data about planets Mars and Jupiter. Manned spacecrafts carry humans and equipments to space.
- These spacecrafts are larger and have specially built compartments which have the facilities necessary for human survival such as oxygen, pressurized cabins, food, water and specially built bathrooms.
- They also have special structure to protect from dangerous radiations which are very intense in space.

Spacecraft

Space Stations

- For very long stay in space or for performing experiments in space, large spacecraft called **space stations** are used
- space station is built in space by carrying its many small parts to space and then assembling them there. It has more facilities for prolonged living in space.
- It may have television for entertainment, bags for sleeping, exercise machine and kitchen for fresh food.
- One important part of a space station is the scientific laboratory where astronauts perform such experiments that cannot be done on Earth because of its gravity.
- Now-a-days a large space station orbits the Earth. Russians, Americans and other scientists jointly work in this space station. This is called international space station.

Space station

Space shuttle

- It is an especially developed manned space craft which can be used many times.
- It is sent into space with the help of a rocket . It carries scientists and equipments.
- It docks with the space station to transfer its load. After performing its task, it returns and lands back on Earth like an aeroplane.

Space shuttle

12.2 Space Exploration

- Scientific study of the space using especially developed technology is called space exploration.
- Common objectives for exploring space include advancing scientific knowledge, ensuring the future survival of humanity and developing defense capabilities.

12.2.1 Benefits of Space Exploration

- Special technologies developed for space are now being used on Earth to improve the quality of life. A few examples are as follows:

Health and Medicine

- In the field of health and medicines, space exploration has enabled man to develop medical devices such as WARP 10 and hand-held high intensity LED unit etc.
- These machines are used for getting relief in muscle, joint pains and arthritis

High intensity LED unit

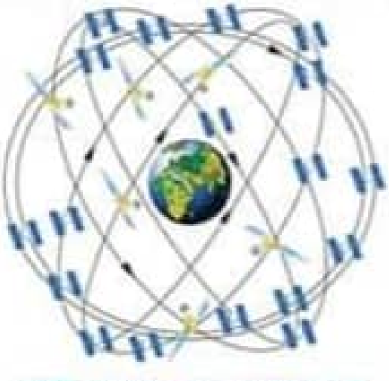
- The infrared thermometer has been developed to measure the temperature of body without contact
- Kidney dialysis machines and mini cameras for taking the photographs of internal organs of human body have been developed using the research output of space exploration.

Infrared ear thermometer

- The materials used to keep our homes warm are based on the technology used for insulating the space stations.

Global Navigation

- § Geostationary Orbits and Global
- Positioning System (GPS) use the network of satellites orbiting the Earth to facilitate communication and essential navigation



GPS satellites around the Earth

- This system helps our television receivers and mobile phones to catch signals from the satellites moving around the globe.
- § The travellers can use this system not only for knowing where they are travelling but also for selecting best route to their destination.
- Aeroplane pilots, sailors of the boats or desert hikers also use the GPS in mobile phones to find their positions and get information about the surroundings.

Weather Forecast and Prediction of Natural Calamities

- The accurate and reliable weather reports on hourly basis are possible because of the weather satellites in the space these satellites have also made it easy to predict natural calamities such as floods, storms, tornadoes and hurricanes.

Weather satellite

Advanced Electronics and Computers

- Electronic and computer systems were developed mainly to facilitate space exploration.
- Satellites are fitted with electronic and computer systems which can perform many functions automatically.
- Now-a-days many items are made in factories automatically or by computer controlled robots.

Locating Minerals, Fossil Fuels and Water Reserves

- Deeply buried precious ores of minerals, fossil fuels (coal, petroleum and natural gas) and underground water reserves can be located with the help of satellites. This study is known as remote sensing.

Locating ores and resources

12.2.2 How do Astronauts Survive and Research in Space?

- For living in space, astronauts need basic necessities (air, food, water, shelter and warmth) for survival, and a suitable compartment for personal comfort on the spacecraft.
- For this purpose, large space stations have been built in the space.

- Each space station consists of two main sections.
  1. Pressurized section in which scientists work without space suits.
  2. Open-to-Space section on which equipment is mounted for observing the Earth and sky. Unprotected human body cannot survive more than a few minutes in space. As liquid boils at lower temperature at lower pressure, the water in human body can begin to boil at low pressure resulting immediate death.
- The astronauts wear a specially designed suit called **space suit** to protect from such hazards when they go out into space

Astronaut wearing space suit

- For breathing in space, they carry air tanks with them that contain pressurized oxygen and nitrogen.
- Their suits circulate the air to their helmets and throughout the suit so that they can breathe.
- Special foods are prepared and packed for easier transportation and a variety of tastes for the astronauts.

12.2.3 Problems Created by Space Exploration and their Solutions

- Space sickness, effects of weightlessness, conditions resulting from exposure to radiation and many unwanted side effects are the problems created during the stay in space.
- Pollution caused by burning of rocket fuel and disposal of rocket parts, etc. is one of the major problems created by space exploration.
- Hazards for the space crew on missions are the main problems. Many deaths have resulted during the manned spaceflights.
- Space scientists and engineers need continuous work to improve safety in space missions.
- Skylab fell from its orbit to Earth in 1979. This type of incidences could be dangerous for population.
- Space programmes are very costly. These are causing economic burden on common man. Involvement of private sector in missions could be a possible solution.

12.2.4 Technological Tools Used in Space Exploration

- A few of the tools which are used in space exploration programmes are mentioned as follows:

Space Rockets

- Space rockets are the means of transporting spacecrafts, space shuttles and space stations into the space

Space rocket

Rocket Launching pads

- The sites from which rockets are launched into space are called Rocket Launching Pads

Rocket launching pad

- These are especially built platforms for firing rockets into the space. They can withstand extremely high temperature and large forces produced by rocket exhausts.

Telecommunication system

- Rockets and spacecrafts are provided with telecommunication system so that the space crew in the rocket capsule can communicate with each other and with the Earth stations.

Ground Mission Control Stations

- Ground stations receive and process the information from satellites to monitor and guide their motion in space. The main tasks of ground mission control are as follows:
- **Tracking**: Continuously reporting the position of the satellite or space probe.
- **Monitoring** : Receiving signals from a spacecraft and decoding them into useful information for the scientists is known as monitoring. Progress of a space mission is closely observed and necessary instructions are issued from time to time.

12.2.5 New Technologies Developed on the Earth as a Result of Space